THE USE AND ABUSE OF THE AUTOMOBILE

BY PROFESSOR K. F. NICHOLAS

KANSAS CITY MISSOURI

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MAIN CLASS-ROOM. PROF. K. F. NICHOLAS

Foreword

IN THE following pages you will find the use and abuse of the automobile explained and illustrated as thoroughly as it can be on the printed page. I do not claim that you will be able to learn to be an automobile specialist out of this book alone, for you will discover it is not possible for me to illustrate things as plainly to you in a book as I could if I had you in the class room. However, I do claim that any person who has ever gone through the school room and has heard the instruction given there and the illustrations explained, I do claim that this will bring back to him the things as fresh as the day they were in the class room. You must also realize that you are reading a matter which is not being illustrated by the real article. And yet I do claim that you can get a great deal of good out of this book if you are one who understands anything at all about an automobile. I am certain that after you have read this that you will get more than your money's worth out of it and will be overpleased with what knowledge you have received from the book alone. I believe it is made plainer in this book than in anything yet published. Also the instruction herein is taught the same as you will find in the class room, and the one who is teaching you is one who has had the real experience.

The USE *and* ABUSE *of the* AUTOMOBILE

By PROF. K. F. NICHOLAS

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IN TAKING up the automobile business, it is really necessary for a man to go to the very bottom so that he may be able to understand every working principle and part of the gasoline engine. Trying to learn this out of a book is impossible. The book principle is to give a man back what he has forgotten, since you can refer back to this and get my instruction just as it was taught in the class room.

To understand its principles, the automobile ought to be taken up just as it was when first invented. Booty Roe was the first man to invent the first four-cycle gasoline engine, although the gasoline engine was not the first propelling vehicle that was ever invented. Steam power was the first, and it made a failure. Later the locomotive took its place. Afterwards steam developed into the automobile, and still later Booty Roe, who discovered that gasoline had power, put it to work. You will notice now that we have the three propelling vehicles—gasoline, steam and electric.

In taking up gasoline, it is really necessary to understand the use and abuse of the gasoline engine. There is no piece of machinery on the face of the earth that is abused any more than the gasoline engine. In contrast look at the locomotive. It runs over smooth rails, and every night when it comes into the round house, it is looked carefully over by mechanics who understand their business, while the gasoline engine on the automobile goes out over the rough roads and is abused from morning to night, and is then run into the shed and has no care whatever. The next morning the man who operates it starts it for its next day's abuse. Did you ever notice that the following usually takes place when a man buys a brand new car?—you certainly have if you are the owner of a car! A man is sent out to you who is supposed to understand his business. He tells you how to operate your car. The first thing he tells you is to be sure to always release your clutch. He has told you wrong when he told you that. The second thing he will tell you is how to turn on the spark, how to change speeds and how to start a car. After he has left you, then your trouble begins, for the first thing you will do is to go to your car, undertake to start it. And when you do, you will find that it fires backwards, giving you a very severe lick upon the leg or arm, maybe breaking some limb. If this doesn't happen, by the time you get into your seat and undertake to start the car, you will hear a ripping and roaring sound coming from your gears. This is nothing more nor less than the fault of the driver, as you will readily learn when you get further advanced in this book. Another thing you will notice after starting the car, although you may start out all right at first, after changing speeds from first to second, you will find that it gives you a great deal of trouble to change these speeds without making a noise. You may discover that it may not be even this that troubles you, but something else. In short, it will be well worth your time to read this book, as it may be the cause of saving your life.

Suppose you should go to your car in the morning, not having been warned against the dangerous points, and undertake to start it while it was in high speed. You would find your car would make one lunge, leaping over you, and perhaps breaking your neck or back. This has happened to several men among my acquaintance in Kansas City, and is likely to happen to you, provided you are not guarded against these dangerous points.

The above are only a few of the facts concerning the abuse of the gasoline engine. Let us continue. The average man who drives an automobile, if you observe, you will notice him start suddenly, and stop suddenly, and you will notice him turn corners at a high rate of speed. You will also observe that he drives at a high rate of speed over rough places. Again, you will see him drive his car, it may be during the evening, then run into the shed and leave it there untouched. That is the last of it until the next morning. Is not this abuse to the gasoline engine? When anything goes wrong, a cold chisel and a hammer is the way he usually starts to repair it. Such repairing as this makes the first expense of a man's car the least. But the second expense becomes greater, due to the abuse of the gasoline engine. Later on, I will give you the knowledge of using one tool that will make your first expense much greater than the second expense, but it will save you in the long run.

If you will go home after driving your car and take a piece of waste and wipe the grease from all the different parts, you will remove your trouble. Upon doing so, you will discover wires that become oil soaked, cause trouble such as shorts. You will also find that grease gathers in your magneto and shorts it out. And again, the vibration of your car causes the different parts of the car to work loose. By wiping over these parts you will learn the parts which are working loose and know what size wrench to use in order to tighten them up. You have also discovered and prevented trouble that would occur later. For every time a trouble shooter is called out to fix your car it means a dead expense. And that expense runs very high and it is just as well that you do away with it. The troubles of the gasoline engine are very easy to overcome, providing you understand the principle of every part and why every part performs its work in the way that it does.

If you are to drive an automobile in the city, it is necessary to understand the rules of driving. In coming to a street car crossing, you should always drive across straight ahead and turn to your left. Again, you should always slow down before crossing a street car crossing. Give yourself a chance to look both ways, seeing that you have the clear; then you are at liberty to cross over. Don't take chances on the boulevards, even if you do have the right of way. Sometimes the street cars don't stop—it may because of the brakes not holding, or it may be because the motorman doesn't care. In driving on slippery, wet streets, you should proceed very carefully. Don't lock your brakes suddenly; don't start your car quickly; as this causes skidding and is liable to result in a great deal of trouble. When old people are crossing ahead of you, it is really not necessary to make a noise, since you will find you will have better success in crossing the street without scaring them than you will if you were to blow your horn and frighten them. If you blow the horn quickly, they are sure to jump back in your road, and the chances are you might hit them.

In driving around a bluff or any other place where you notice an icy or slippery place ahead of you, always release your clutch and release your brakes and let your car coast over. To illustrate, when driving a wagon down a hill, if you lock the brakes, the back end of the wagon will try to beat the front end down. By releasing the brakes, the wagon will straighten up at once and pushes the horses ahead of you. Finding you have no horses to an automobile, this will not happen; but if you release your brakes your car will stay straight in the road and will coast over the icy, slippery place without a bit of danger. Otherwise, it is liable to skid sideways and go over a bluff if there is one, which sad experience has happened to a number that I know of, and has caused loss of life to several.

In starting an automobile, the proper thing to do is to always see that your spark is retarded, and that your levers are in neutral. Then, by placing your thumb behind the crank, and by pulling very quickly, you will find that your motor will start off without any danger. After taking your seat in the car, release the clutch clear out, advance the spark about half, and throw your lever into first speed. Then leave the clutch in easily. When the car starts off, just release the clutch far enough to release the motor power from the transmission and shift over from first to second very quickly. To your pleasure you will find that this can be done without making a particle of noise. Then from second to high. Do the same by releasing the clutch just far enough to release the motor power from the transmission and shift into high speed quickly, lifting your clutch back slowly. You will find that no noise will be made by shifting in this way, as you allow the jack shaft to keep running as well as the drive shaft. These gears both running will slide together without making a particle of noise.

After your car is in good motion, don't lock your brakes suddenly, as it causes a very severe strain upon every part of the gasoline engine. When the brake is locked suddenly it throws a strain upon the jack shaft, upon the drive shaft, upon the propeller shaft and to the differential. This shock or strain has been received all the way through to the rear axles on the rear wheels, and is very apt to cause crystallization. Crystallization will keep working until it has finally lost its strength and gives way. The metal looks like it has been rubbed together, except right in the heart of the piece of metal, which you will find is a fresh break, which has been crystallized in that part, and this part not being strong enough, breaks. Sudden stoppage of a car also throws a strain upon the beads of the tire, and in time causes it to give way.

THE WAY TO AVOID TROUBLE

By first going to work and straining your gasoline through a chamois skin, you will find that you avoid a great deal of trouble that will occur otherwise. The gasoline, after leaving the oil wells, is hauled in a large tank, from which it is poured into tanks here, and from these tanks to your automobile. During this transit a great deal of dirt has gathered since the time it left the oil well. This dirty gasoline, entering the tanks of the car, will cause trouble, which, of course, means expense to the man who owns the automobile. By straining the gasoline thoroughly through a chamois skin, you avoid this trouble altogether. Sometimes water will be found in gasoline. If this be the case, by straining it through a chamois skin, the water also will be kept from passing through. If the gasoline should enter the car dirty and stop it up, such trouble can be located in five minutes from the time you reach the car, provided the owner is an all round expert. But if he is not, he should avoid this trouble.

BROKEN PARTS AND THE WAY TO GET HOME

If you were to break a rear wheel of your car, at first it would seem almost impossible to get home. However, by taking a pole and placing it under the car, the same as you would on a wagon, fastening it to the front axle or to the running board, then tying your rear wheel to the pole that is broken so that it cannot turn, you will ascertain with pleasure that you can drive home with the other wheel, since it is bound to turn. This is due to the differential which allows one wheel to stand still while the other one runs twice as fast.

Should you strip out a set of transmission gears, you can also drive home by throwing into high speed. You have what is called a "direct drive." This does away with all the gear power, and you are able to drive in on high speed. You will have to bring your car up to a fairly high speed, allowing the clutch to slip while starting your car. After once getting started, it is no more trouble to drive home this way than it is any time when driving on high speed.

If you should happen to break a connecting rod, by going to work and removing the Cylinder and taking out the broken parts and placing the cylinder back on, release the push rod on the intake valve of the dead cylinder, and you will find that you can drive home on the other three cylinders, or the cylinders that you have left.

Should you break a propeller shaft, splice it the same as you would a broken arm by placing four pieces of iron round the sides and wrapping tightly with a piece of wire. Fasten a piece of wire from the front universal joint to the back universal joint, wrapping it in the opposite direction from the way the propeller shaft turns. You will find that both pieces must then go together.

In case that your radiator should happen to be leaking badly when on the road, by getting some corn starch and dissolving it in a bucket of water and pouring this into the radiator, you will discover that it will check the leak at once, and you will be able to drive home without any delay.

In case you were to strip out the differential gears, by going to work and taking the differential out and block the gears with a piece of wood, you will be able to go to work and make a stiff drive in which you could drive home without any trouble. However, you must be careful in turning the corners, as one wheel has to slip on the ground while the other one turns.

In case your clutch gets to slipping, and will not hold (if you have the comb clutch), you can raise it by slipping a hacksaw blade under the leather, or a piece of wood, tin, or anything that will raise the leather so that it will seat tight when the clutch is left in. This will keep it from slipping and will allow you to get home safely.

Say that you were to get in a mud hole and one wheel was on good footing, and the other one was in the mud hole, was turning round and wouldn't hold. A good way to stop this is to knock the pin out on the brake rod on the side of the wheel that is on good footing. This will allow you to lock the brake on the wheel that is slipping and keep it from doing so, as the other wheel will have to turn then and will take you out of the mud hole without a bit of trouble.

If your lamps should go out and you had no matches after night, to light them is a very easy matter. Just take a piece of paper, dip it in the gasoline, take off a high tension wire and allowing the spark to jump across to the paper. This will set it afire, and you can light your coal oil lamps. Then one of those can be taken round and light the rest.

In case a universal joint should give way on one side, about the only way of driving home on your own power is to drive backwards. This can be done without any trouble.

FOUR VIBRATING COIL

The Four Vibrating Coil is a system which is used on a great many cars. It has its good principles and bad principles the same as any other system.

The Four Vibrating Coil consists of four units which have a primary and secondary winding. The figure you see here gives you a plain view of the Four Vibrating Coil, wired up as it should be on the car itself.

It is really necessary for you to go to the very bottom in order to understand the principle of this coil. You will find in taking up the Four Vibrating Coil, or any other coil, one must also understand the effects of lines of force. You will discover that in winding wire in which you flow a current over will create a line of force which cannot be seen, but the effects can. For instance; take a piece of iron; wrap a piece of paper round it; then wrap a wire over; connecting each end of this wire to a set of batteries, and you will find that the iron core becomes magnetized. It is through the lines of force that the iron core becomes magnetized. Hence, you will find wherever there are lines of force there is magnetism, and wherever there is magnetism, there are lines of force. In order to understand this clearly, it is also necessary to be where some one can demonstrate this principle as well as teach it to you. In this teaching you will discover why we are trying to impress upon you that lines of force are magnetism and magnetism is lines of force, for it is really necessary to understand this thoroughly in order to understand how we create a secondary current. A secondary current is made by the breaking of the lines of force. By this method, you will find, the spark was created as hot as it is, and hence the current used on automobiles goes as high as 20,000 volts, starting out with a voltage of five to six. This is done by means of the induction coil.

The first ignition system which was used was the Make and Break system, in which they used the spark coil, and still do today, on a stationary gasoline engine; but on automobiles we used the induction coil.

To increase the current on an induction coil, it is stepped up by flowing a primary current over a primary winding, which creates a line of force by breaking this current. Then it breaks the line of force and creates a high tension current in the secondary winding, in which this current will go ten to one as the winding is made that way. We do not mean one wind of the primary and ten of the secondary, but we mean one of the primary and ten thousand of the secondary. This raises the voltage which is carried to the spark plug, as the high tension current will jump almost three-fourths of an inch. This makes a very hot spark and if you were to take it direct through your body, it would "tie you up" in a knot. You wouldn't be able ever to let go. The shock that you receive from the motor is merely a slight shock, as the entire current doesn't go direct through your body, but only part of it.

In Figure No. 20 I shall explain the Four Vibrating Coils in a way that you may understand the principle from the beginning to the end. It is necessary that a person should understand how to find out the way a motor fires and how to find the compression stroke dead center, and also how to set a timer of magneto.

No. 1 on the figure shows the positive connection; No. 7 shows the negative connection of the storage battery; No. 2 shows the connection of the switch; No. 3 shows the primary wire in the coil box; No. 4 shows the terminal from the coil box to the timer; No. 5 shows the terminal at the timer; No. 6 represents the current returning back to its point of starting; No. 8 shows the high tension current feeding out of the high tension terminal, and No. 9 shows the spark plug where the high tension current feeds to, which is No. 1 cylinder, or should be.

We always have a system by using one end or the other of the motor for No. 1. By using the cylinder next to the radiator for No. 1, you will find you are following the rule as many mechanics do.

As you wish to find out the way this motor fires, you will notice the intake valves and exhaust valves are colored green and red. The green valve stems are the intake valve stems. The red valve stems are the exhaust valves, which will be found nearest the exhaust manifold opening. The intake valves are found nearest the intake manifold

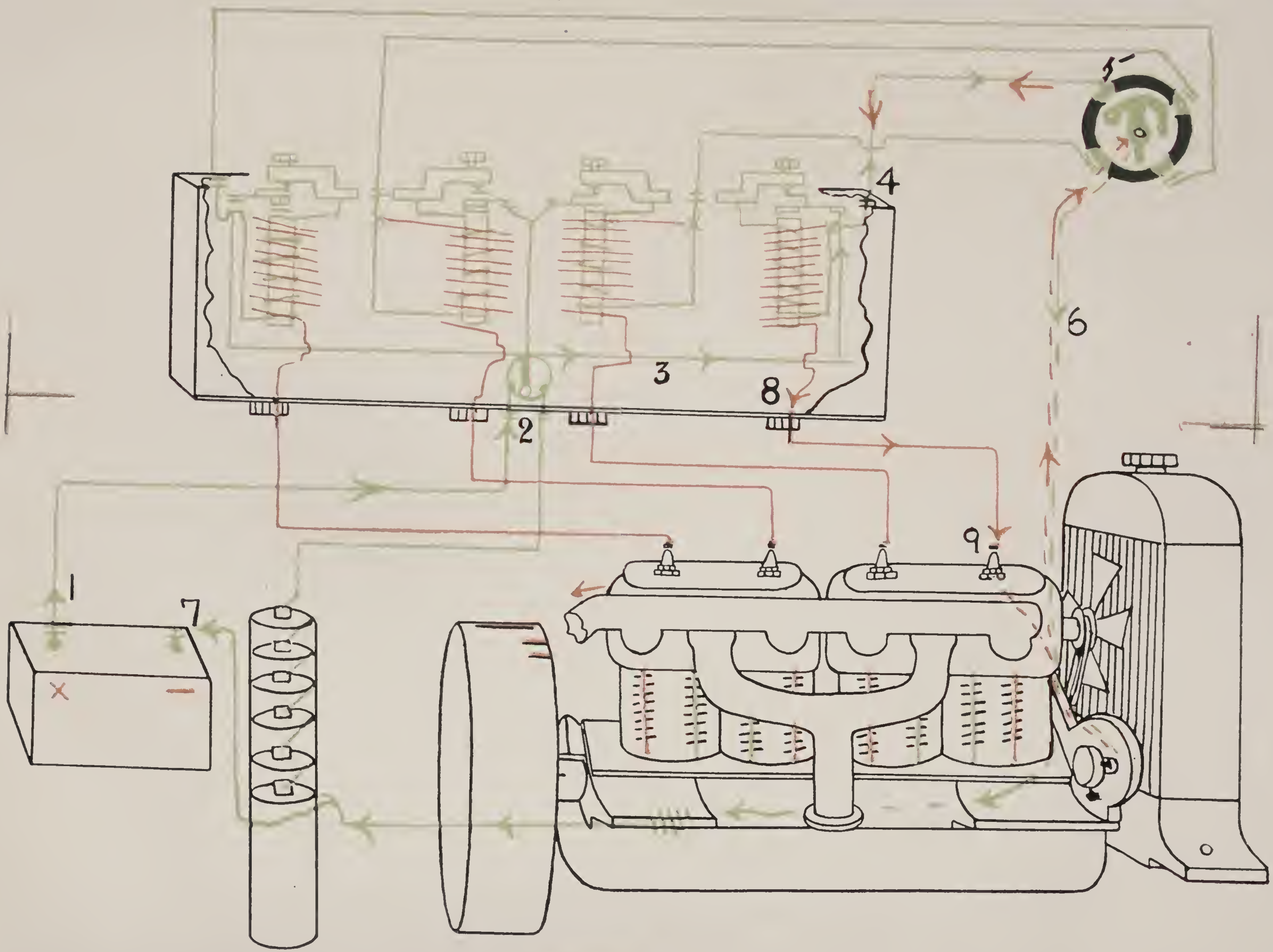


FIG. 20. FOUR VIBRATING COILS.

opening. To find the way your motor fires, watch the exhaust valve open and close on No. 1 cylinder; then place your thumb and finger on Nos. 2 and 3. If No. 3 opens next, it fires 1, 3, 4, 2; but if No. 2 opens next, it fires 1, 2, 4, 3.

Now, to find compression stroke dead center, by watching the exhaust valves open and close on No. 1 cylinder, you must turn the fly wheel one complete revolution, getting dead center mark even with the center of the cylinder and it will give compression stroke dead center on No. 1 cylinder. Or, by watching the exhaust valve open and close on No. 4, and getting the dead center mark even with the center of the cylinder, it will give you compression stroke dead center on No. 1. Then set your timer. Fully retard the timer and set it so as to be just ready to make contact with No. 1 point.

After setting your timer so it is just ready to make contact with No. 1 point, you are then ready to start to wire up. Wire your high tension wires in rotation as they are in the drawing. Wire your primary wires from No. 1 point of the batteries to the terminal of the switch, No. 2. The other point of the batteries must be connected to the ground, which is the frame of the motor. Then you will wire your primary wires from your timer to the coil, according to the way the motor fires. As this motor fires 1, 3, 4, 2, you wire No. 1 point to No. 1 point on the coil. You wire No. 2 point on the timer in the direction that the timer hand turns to No. 3 on the coil; you wire No. 3 on the timer to No. 4 terminal on the coil; you wire 4 point on the timer to No. 2 terminal on the coil. This will make your motor 1, 3, 4, 2.

At this point we will trace the current as it travels from this system and what takes places as the current is traveling. When turning the switch on at No. 2, the current starts out on the positive side, No. 1. It passes across switch No. 2, up to the spring over the green wire, across the spring and through the adjustment screw, through the primary winding to terminal No. 4. Then it passes to the timer terminal, No. 5, where it passes in on the contact maker across the shaft, No. 6, from whence it passes down over the green wire back to the batteries where it started from. While this current is passing through the primary winding it creates a line of force, causing the iron core to become magnetized, draws the spring down and breaks the current. Breaking the current, it breaks the line of force and creates a high tension current in the secondary winding. This current passes out over the high tension wire to the high tension terminal, No. 8. From this it passes to the spark plug, No. 9, where it returns over to the timer over the red dotted line. There it passes back through the timer as the red arrows point back through the primary wire, back to terminal No. 4, where it returns back into the secondary winding from which it started.

You will find that No. 1 cylinder fires down; No. 2 cylinder comes up exhausting; No. 3 cylinder comes up compression; and No. 4 cylinder goes down, taking in a charge. As No. 3 cylinder reaches compression stroke dead center, the timer has moved from 1 to 2. As it reaches No. 2 contact point, it closes a circuit again in which it this time passes from the positive side, No. 1, to the switch No. 2, passing over the primary winding, No. 3, to the contact point, No. 2, on the timer. There it returns back over the frame of the motor, back to the batteries where it started from.

While this current passes through No. 3, it creates a line of force, causing the iron core to become magnetized and draws the spring down, breaking the current. Breaking this current, it breaks the line of force and creates a high tension current in the secondary winding, which rushes out over the red wire passing down to spark plug No. 3. There it returns back through the timer, over the primary wire to the secondary winding where it started from. As this takes place, No. 3 cylinder fires down; No. 4 comes up on compression stroke; No. 1 comes up exhausting; No. 2 goes down taking in a charge. As No. 4 reaches compression stroke dead center the timer has moved from 2 to 3 where the circuit is closed again. This time the current passes from the batteries No. 1 to the terminals of the switch No. 2, passing over the green wire to No. 3 coil where it passes through the primary winding. There it returns over to timer contact No. 3, and returns back over the frame of the motor back to the batteries where it started. Also, a line of force is created in this coil, causing the iron core to become magnetized, draws the spring down and breaks the current and breaks the line of force. Breaking the line of force, it creates a high tension current in the secondary winding which rushes to the spark plug No. 4. There it returns back over the frame of the motor to the timer, returning back over the primary wire to the coil where it started.

As No. 4 fires down, No. 1 goes down taking in a charge; No. 2 comes up compression and No. 3 comes up exhausting. As No. 2 reaches compression stroke dead center, the timer has moved from 3 to 4 where the circuit is closed again and the current passes from the positive side of the battery passing through the switch where it passes through No. 2 coil. There it passes out from the terminal to No. 4 contact point on the timer, returning back over the frame of the motor, back to the batteries where it started from. Also, this current passing through creates a line of force, causes the iron core to become magnetized, draws the spring down and breaks the current, and breaking the current, breaks the line of force and creates a high tension current in the secondary winding, passing out to the spark plug No. 2. There it passes down over the frame of the motor, returns back over the primary wire to the timer, back to the secondary winding where it started from. This causes No. 2 cylinder to fire down. No. 1 comes up on compression stroke, and No. 4 comes up exhausting and No. 3 goes down taking in a charge. The timer has moved back to No. 1 contact point to where it started from. Each one of these cylinders has completed a cycle, as each cylinder has come back to the same point of starting, and a cycle of a four-cycle gasoline engine is one which completes four duties in two revolutions.

You may wonder why the current passes to No. 1 coil first and doesn't pass through all the coils at once. If you will notice, tracing the current through any of the other points but No. 1, you will come to the timer and you will find that there is no way for the current to go across, as this timer is insulated between the green points. The green points are the only places that they can make contact or close a circuit. The dark points, you will find, are insluated, or otherwise are fibre in which the roller passes over and cannot make contact in any way, shape or form without making contact with the terminals. This way, the wires being connected as they are, the current must flow through first No. 1, then 3, 4, and 2.

You may also wonder why we retard a spark when setting the timer. Of course you realize we advance the spark when the motor is running. The reason we do so is because it takes a space of time for gasoline to burn up. As it takes a space of time, we have got to ignite the gas ahead of time since the motor runs at such a rate of speed that the gas will burn up by the time the piston has reached the dead center, giving us the full benefit of the explosion from the very top down. If we were to ignite the gas on dead center, the gas would be burning and would release, which would cause a great deal of heat and also a loss of power, as you will find that the piston had traveled part way down before the gases would burn up and therefore the explosion would take place too late. You must understand that the piston travels further on the first quarter than it does on the last. For that reason we have got to gain all we can on the first stroke. By gaining our explosion on the dead center, we get the full benefit of the explosion stroke from the top down. So, by setting the timer fully retarded, and setting it to make contact as it comes on dead center, when we advance the spark we ignite the gas while the piston is coming to the top. This way the gases are burning while compressing. The burning of the gases gives greater combustion, which, when fully compressed, gives off a greater explosion than it would if it was to be ignited and even burned on the dead center. This is why we gain so much power out of such small cylinders.

TROUBLES OF THE FOUR VIBRATING COILS AND HOW TO LOCATE THEM

If there is a continual buzz of the vibrator and back firing through the carburetor, the trouble is found at the timer. This is caused from dirt, from oil-soaked wires, broken insulation, or wires coming off from the timer touching the frame of the motor somewhere. This trouble is always found at the wires that are connected at the timer or in the timer itself. The reason for this is a continual flowing of current of the primary circuit, which causes a continual line of force. This causes the iron core to be magnetized continually, causing a continual vibration. As it draws the spring down and breaks the line of force continually, it continually creates a high tension current in the secondary winding. This passes to the spark plug, and hence at the cylinder you will have a continuous spark, which, the moment the gas is drawn in this cylinder, is ignited and fired back through the carburetor. If the wire No. 1 at the storage battery was to get shorter or touch the frame of the motor in any way, it would cause the battery to discharge very fast and chances of ruining your battery.

If the wire of the dry cells leading to the switch No. 2 should happen to get shorter, by chance it might stop your car from running. However, I have known it not to do so for some time, and yet when it did so, would still give off a spark. In this trouble you will find you will have a spark, compression and gasoline, which is a very hard combination for the ordinary man to locate; but it can be located in five minutes by understanding it thoroughly. First take gasoline from the top of your tank and prime your cylinders, about a teaspoonful to each cylinder. You may ask, "Why do you take gasoline from the top of the tank?" Because gas is always lighter and is bound to be at the top. If there is any water in the gasoline it is most surely to be at the bottom. By primming your cylinders with water you would be thrown off on to the wrong trail of trouble. After priming your cylinders with gas from the top of your tank, crank the motor over. If three or four explosions take place, that insures you that your spark is in good shape and will ignite the gas. This trouble is found in the carburetor, showing that the gas is not getting to the cylinders as it should. By trying to flood the carburetor, you will soon locate this trouble. If the carburetor will flood through the air valve, you will know water in your gasoline is causing the trouble and your carburetor is full. If this cannot be flooded, it shows that the spray nozzle is stopped up and will not allow the gasoline to pass through. By removing either the needle valve or the plug at the bottom (should it be a spray nozzle) you can remove this dirt without any trouble. Should it be water, by draining off about a pint, generally removes the water trouble.

Should you find that by priming your cylinders the gas would not ignite, insure yourself that your timer is properly set by putting your No. 1 cylinder on compression stroke dead center, and see if your timer is just where it can make contact. Finding this proper, your trouble lies between the switch, the batteries, the ground wire, loose connections, oil-soaked wires, or missing cylinders. To locate this trouble, first, turn the motor over with the switch turned off, seeing whether your compression is good on all four cylinders. If not, the trouble is very apt to be that the valve is probably being held open by carbon or some other cause. If not, and the compression is even, by taking a screw driver and placing at each plug while the motor is running, you will find that each cylinder works out the same, allowing just one cylinder to miss at each point when shorter, and the trouble is that your carburetor is not properly adjusted. If you find that one of these cylinders that you short out, shorts out with your screw driver when allowing two to hit, keep on until you find the one that makes no difference, so that when shorting you still have three hitting. Then you have the cylinder that is missing, as it makes no change by shorting. Take the high tension wire off and see whether the high tension current is feeding to the plug. If it is, remove the plug. If full of grease and dirt, there is your trouble. If not, take the plug to pieces. If the porcelain is cracked, that is your trouble; but if not, your trouble is somewhere else. Then go to work and look at your vibrator on the coil which is feeding that plug. If you find your platinum points are pitted or in bad shape, that is your trouble. If not, go to work and change the coil to a place of one of the others and place the other one in its place. Finding that this coil will not work at the other place, the trouble is that the coil is broken down, which is caused by using too many dry cells on the battery. We should only use six dry cells on a four vibrating coil, or three-cell storage battery.

To adjust these vibrators, go to work and short circuit your timer. Then you can cause the vibrator to operate, and you will be able then to adjust it until you get a rich, "honey bee" hum.

FOUR UNVIBRATING COILS WITH MASTER VIBRATOR OR DOUBLE IGNITION SYSTEM

The view which I show you next, in Figure No. 25, gives you a plain illustration of four unvibrating coils with a master vibrator and a high tension magneto in connection. This view shows your sectional figure of the cylinder that shows you plainly that a motor cannot fire in rotation. As you will notice, No. 1 piston and No. 4 piston are at the top, while No. 2 and No. 3 are at the bottom. Now, should No. 1 fire down, No. 4 would have to go down with it. That would bring 2 and 3 to the top. Should No. 2 fire next, it would undoubtedly take 3 down with it, which plainly shows that it would be impossible to fire No. 3 next, as it would be at the bottom with No. 2, though since this would bring 1 and 4 to the top, you would be able to fire No. 4 next, which would make it fire 1, 2, 4, 3. Otherwise, you could fire No. 1; then 3; then to your 4 and back to 2.

This figure shows you an independent system of the ignition system in the high tension and the primary circuit. They are not connected together in any way. The breaking of the line of force for these coils must be done by the master vibrator. The master vibrator receives its name because it is a master over the other four coils.

With this system we get practically the same spark from each and every coil for the simple reason that the break is the same. At each and every time that the current flows through the master vibrator, it passes through one of these coils and the same line of force is created in the master vibrator that causes the break to take place and causes it to be exactly the same. Breaking the line of force, the same will give off more of a uniform, even current than it will with a later or slower or quicker break.

The current after passing from the master vibrator, passes through these coils, and creates a line of force in the unvibrating coil. This coil has two windings, a primary and secondary. In the breaking of the lines of force, there is a high tension current created in the secondary winding.

The high tension magneto, which is in connection with this system, will be explained to you later on, as we would rather take up the magneto all at once and take it up carefully through the same course that we do each system when in the class room.

First, then, we will start in with this system the same that we would with any other to wire it up on the car. The first thing to be done is to find out the way your motor fires, which is done by watching the exhaust valves open and close, and the way they open and close is the way the motor fires.

Always start at one end of the motor for No. 1. After finding the way your motor fires, then go to work and find compression stroke dead center. You will do this by watching the exhaust valves open and close on No. 4 cylinder, and as it closes to the dead center mark even with the center of the cylinder, you will then have compression stroke dead center on No. 1 cylinder. After getting compression stroke dead center, you must set your timer so that it is ready to close the circuit at this time. Do this by retarding the timer as far as possible. Then set the contact maker just ready to make contact with one of your points, which point must be No. 1. After setting the timer and fastening it so it cannot slip, you are ready then to start wiring up.

Start one side for No. 1 of your coils. Wire these high tension wires in rotation, as you see them here. Then connect one wire to the other terminals of the secondary winding, and connect a wire to each one of these terminals fastening it to the frame of the motor, which makes you a high tension return. Now, we will start from the batteries No. 12. Wire these batteries in series, that is, from zinc to carbon and so on through each, which gives you a series wiring. This raises your voltage, leaving amperage stand the same on the six dry cells as it does on one, making the life of these six batteries the life of one. Then connect No. 1 point to No. 2, which is the primary terminal of the master vibrator. Wire No. 4 terminal from the master vibrator to each one of the terminals of the unvibrating coils on one side. This gives you a feed line to the unvibrating coil. Then connect up your switch which must be connected the same as the motor fires. As this motor fires 1, 3, 4, 2, you will find we have it wired in that way. Wire your No. 1 point to No. 1; wire your No. 2 to No. 3; wire your No. 3 to No. 4; and wire your No. 4 to No. 2.

You will please notice that we have this motor firing at the back of the machine in place of the front. We use the back cylinder for No. 1, showing that you can use either end, it making no difference. The cylinder which you start with must be put on compression stroke dead center before undertaking to set the timer.

Now, that we have this wired up, you will find the green wires are the primary lines and the red wires are the secondary windings. We start and trace the current through this system until the motor has completed a cycle. The current starts out over the batteries at terminal No. 1. It passes over the primary line to the adjustment screw No. 3, and on across the spring and round the primary winding down to terminal No. 4. There it passes over the feed line which connects to terminal No. 5. The current feeds through the primary winding and passes down at terminal No. 6. At this point it passes up over this green wire in the direction the arrow is pointing to terminal No. 7. You will find it passing into the contact maker at this point, then on across to the shaft, and down over the frame of the motor, it returns back to the ground wire and returns back to the batteries where it started from.

The current, while passing through the master vibrator creates a line of force, also creating a line of force in the unvibrating coil, which the current passes through. While this current creates a line of force at both places, the line of force in the master vibrator causes the iron core to become magnetized, draws the spring down, breaking the current which is crossing, through an adjustment screw to the spring. Breaking this current, it breaks the line of force at both

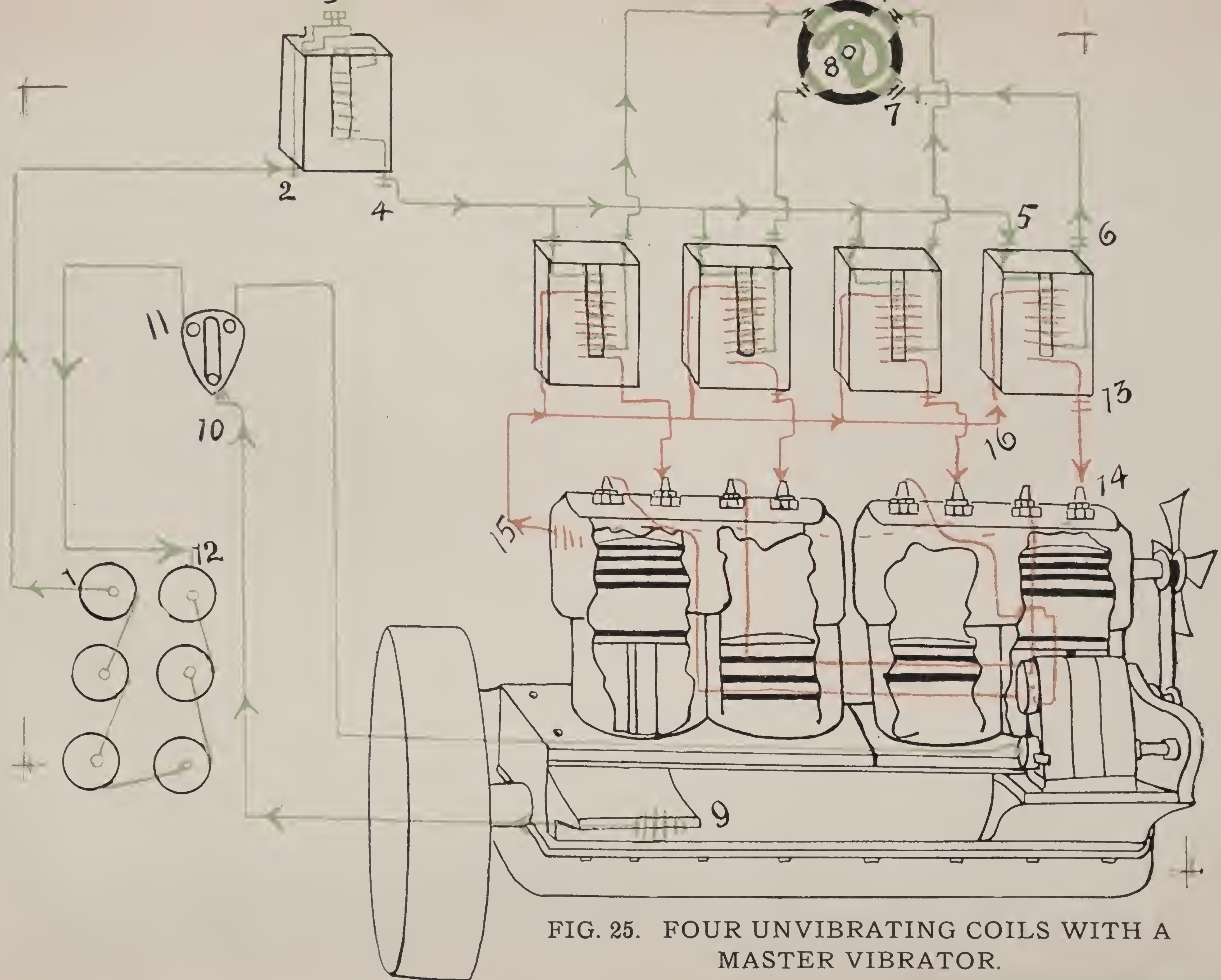


FIG. 25. FOUR UNVIBRATING COILS WITH A MASTER VIBRATOR.

places, the master vibrator and the unvibrating coil. Again, breaking the line of force at the unvibrating coil, it creates a high tension current in the secondary winding. This high tension current passes out over the red wire in the direction the arrow points to the spark plug and passes across the frame of the motor over to the ground wire, No. 15, in the same direction the arrow is pointing. It returns back over the high tension return wire to No. 16, where it returns back into the coil where it started from. As this takes place, you will find that the cylinder at No. 14 fires down. As it does so, your No. 4 passes down with it. Your No. 2 and 3 come up. No. 1 fires down on power stroke and No. 2 came up at the same time exhausting, while No. 3 came up compressing and No. 4 went down taking in a charge. While this is taking place the timer moved from the point it occupied on to the next point, and the circuit was closed again, while the current flowed at once from the battery to the master vibrator and across the feed line again, this time passing through No. 3 coil.

The next point will be connected to No. 3, since the current would pass through that coil and from thence over the frame of the motor it would return back to the batteries from whence it started, the same as the other current has done. The same thing takes effect. The lines of force are created while the current is passing over these primary windings. The spring is drawn down by the magnetized core, breaking the current, and breaking the line of force, creating a high tension current that passes over the coil it is passing through at that time to the cylinder in which the high tension wire is connected.

As No. 3 cylinder fires down, it brings 1 and 4 up. This time No. 4 comes up on compression and No. 2 goes down taking in a charge, while No. 3 goes down on power stroke and No. 1 comes up exhausting. As No. 4 reaches compression, the timer has moved to the next point and it has closed a circuit as you now see it closed on the No. 4 point.

As this circuit is closed the current flows again passing over the feed line the same, only passing through No. 4 coil and from thence it goes to the terminal in which it is making at this time. There it feeds across to the contact-maker which is connected to the shaft and over the frame of the motor your current returns back to the ground wire where it returns back to the batteries from which it started. The same thing takes place. The high tension current is created from the breaking of the line of force, which passes out to No. 4 spark plug and returns back over the high tension return wire, 15, where it started from. This causes No. 4 cylinder to fire down, bringing 2 and 3 up. No. 1 goes down with it taking in a charge as No. 2 comes up on compression and No. 3 comes up exhausting. You will find when No. 2 reaches compression stroke the timer has moved to the next point, in which it closes the circuit again over the primary line. This current passing through the master vibrator again, passes across this time to No. 2 coil. There it passes through the primary winding and passes through the timer where it returns back over the frame of the motor to the ground wire across to No. 10 where it crosses the switch to No. 11 and returns back to the batteries, No. 12, where it started.

You will notice that this current while passing through creates a line of force at both places, the master vibrator and the unvibrating coil, which current is broken at the master vibrator, breaking the line of force at the unvibrating coil, No. 2, creating a high tension current in the secondary winding that passes out to the spark plug and returns back over the frame of the motor to the ground wire, 15, where it returns back to the secondary winding where it started from.

As this causes No. 2 cylinder to fire down, you will find that No. 2 and No. 3 pass down together taking in a charge. No. 1 comes up compressing, and 4 comes up exhausting. As No. 1 reaches compression stroke dead center again, you will find that the timer is back to the same point that it started from. This has completed a cycle as each one of these cylinders has done four duties and they are back to the same point of starting and are ready to start the same duties over again.

TROUBLES OF NO. 25 AND HOW TO LOCATE THEM

If you should be driving along and should drive up to a place to stop and should find when you threw off your switch that your motor kept on running, the trouble would be that the wire connected at terminal No. 11 to the battery and terminal No. 12 would be shorted, or the wire connected at the terminal across from No. 11 would be disconnected and it would be impossible to close a circuit. The thing to do is to short circuit the magneto, since a high tension magneto has got to be short circuited in order to stop it.

Should you hear a continual buzz coming from your vibrator, and at the same time find that you had no spark, the trouble would be that the terminal No. 4 wire leading to terminal No. 5 would be shorted in some way, causing continual current to flow over this wire through the ground wire, No. 9.

Should you have a continual buzz of the vibrator and back firing through the carburetor, the trouble would be that there would be a short in your timer, or the wires connecting to the timer, which causes a continual flow of current, and this would ignite the gas at the moment it reached the cylinder.

Or again, should you be driving along and your car should stop suddenly, by trying to start it, you would learn at once that the car would not go; or should you notice that your vibrator wouldn't even hum, then you must look at your batteries. Finding them all wired up and in good shape, you would begin to wonder if you couldn't start it on the mag. Finding that you couldn't do so, you would make up your mind that your trouble is in the ground wire from No. 10 to No. 9. This wire is disconnected and you will find that neither system will give you a spark.

Should you find that you had one of your cylinders missing, the proper way of locating this trouble is to first see that you have got a compression. Finding that the compression is good, your trouble then is either in the coil or in the spark plug. By examining the spark plug, if you do not find it dirty or the porcelain cracked, you may then go to work and see if your trouble is not in your coil. This can be done easily by changing this coil to the place of another and placing the other one in the place of this one. Finding this coil will not work in the other place and the one put in its place will work, you make up your mind your coil is broken down. The way to fix this coil is to replace it with a new one.

Should you find you have a spark, compression and gasoline, and the motor will not run, you will ascertain that this trouble can be located by priming the cylinders as I have already explained to you. If the gas which you place in the cylinders will ignite, your trouble is in the gasoline system; but should it not, you will know that the trouble in this system lies between the batteries and the terminal No. 2 and the ground wire. This trouble may be weak batteries, loose connections or slight short, in which part of your current passes through the coil and part of it passes back. The amount of current that is passing through the coil does not produce a line of force heavy enough so that when it is broken creates a current high enough to ignite the gas under the compression the gasoline engine goes.

THE UNO SPARKER

The next system which I shall describe to you will be found in Figure 26. The Uno Sparker will easily be remembered. If a person asks you what it is, you may tell him "Uno."

The Uno Sparker is a system which you will find is not used on many cars, but is a very good system, as it gives you absolutely the same spark on each and every cylinder.

You will notice that this system has but one coil, which is a single coil and also an induction coil, that does its own work all the way through. The system is very simple as there is not a great deal of wiring to it. It is very easy to keep up under those conditions. You will not have a lot of wires to become oil-soaked or to cause broken insulation.

The Uno Sparker can be seen in the above view as it is taken apart. The green view is the timer. The black one, which is in the center with the three holes, is to represent a fibre plate that is placed in between the timer and the distributer. The distributer is the case in which you see the red and black marks, the red marks being the contact points and the dark marks are supposed to be solid rubber, which distributer itself is a solid rubber case. There is no chance for the high tension current to pass any other way but in the direction that it should go through this distributer case. The red hand which you see in the center with the black dot in the center of it is the distributer brush that wipes upon the four points round the outer edge of this case.

This distributer and timer are combined together as both are given off of the same shaft, which as it appears in the view is green. This, though, is arranged so that the high tension current cannot interfere with the shaft. When it first enters the distributer and passes to distributer brush there is a solid rubber cap which slips over the shaft. The high tension current feeding in from the top cannot pass through this solid rubber cap whatever, but has got to pass across to the contact points where it leaves the distributer over the high tension wires, going to the spark plugs where it returns back over the frame of the motor to the shaft and then on back through the timer over the green wire, from whence it returns back to the secondary winding.

This system shows you two sets of batteries hooked on the coil. We do not use both sets at once; but either one of these sets of batteries can be used at any time you desire. Should one set of batteries become weak and they would not operate this system, you could switch across to your other set and use them, allowing the set that is not in use to rest. After resting for 12 or 14 hours, or during the night, you will find by turning them on again in the morning when you start you can get an hour or two hours work out of them before they become so weak they begin to give you trouble. This way you can entirely exhaust a set of batteries.

It isn't necessary that you must have dry cells on this system. You can either use storage batteries or use a generator. Any ignition system which will supply you current can be used on this system as well as any other.

We shall go to work and explain how to wire up this system and set the timer and distributer the same as the other systems. Concerning the distributer it must be known and understood that this system is the system which distributes high tension current from one spark plug to another as the motor should fire.

The first thing to do in coming to this motor is to find out the way your motor fires. You do this by watching your No. 1 exhaust valve open and close, and then watch 2 and 3. Should No. 3 operate next, you will find that the motor fires 1, 3, 4, 2. But if No. 2 operates next, you will find that the motor fires 1, 2, 4, 3. This you can easily remember. The next thing to do is to find compression stroke dead center. You do that by watching the exhaust valve open and close on No. 4 cylinder, and then getting dead center mark even with the center of the cylinder and this gives you compression stroke on No. 1. Or, you can watch the exhaust valve open and close on No. 1, and then turn your fly wheel one complete revolution and it will give you compression stroke dead center on No. 1 cylinder. After doing this you are ready to set your Uno Sparker.

Set the timer the same as any other timer so that it is just ready to make contact with one of the points while the timer is fully retarded. Then place the fiber plate over the top. Next place your distributer brush through the center hole which fastens to the shaft. This cannot be put on wrong, as it will only go in one way; but after placing it on, notice exactly the direction in which the brush is pointing and then place the distributer over the top of it. As you have observed the way the brush is pointing, you will find it is pointing in the direction of one of the terminals on the distributer. This terminal is No. 1. The next one is No. 2, in the direction that the distributer hand turns. The next is 3 and 4, so on in rotation. Wire No. 1 points to No. 1 cylinder. Wire the next point to the next cylinder that fires. As this cylinder fires 1, 3, 4, 2, you will notice

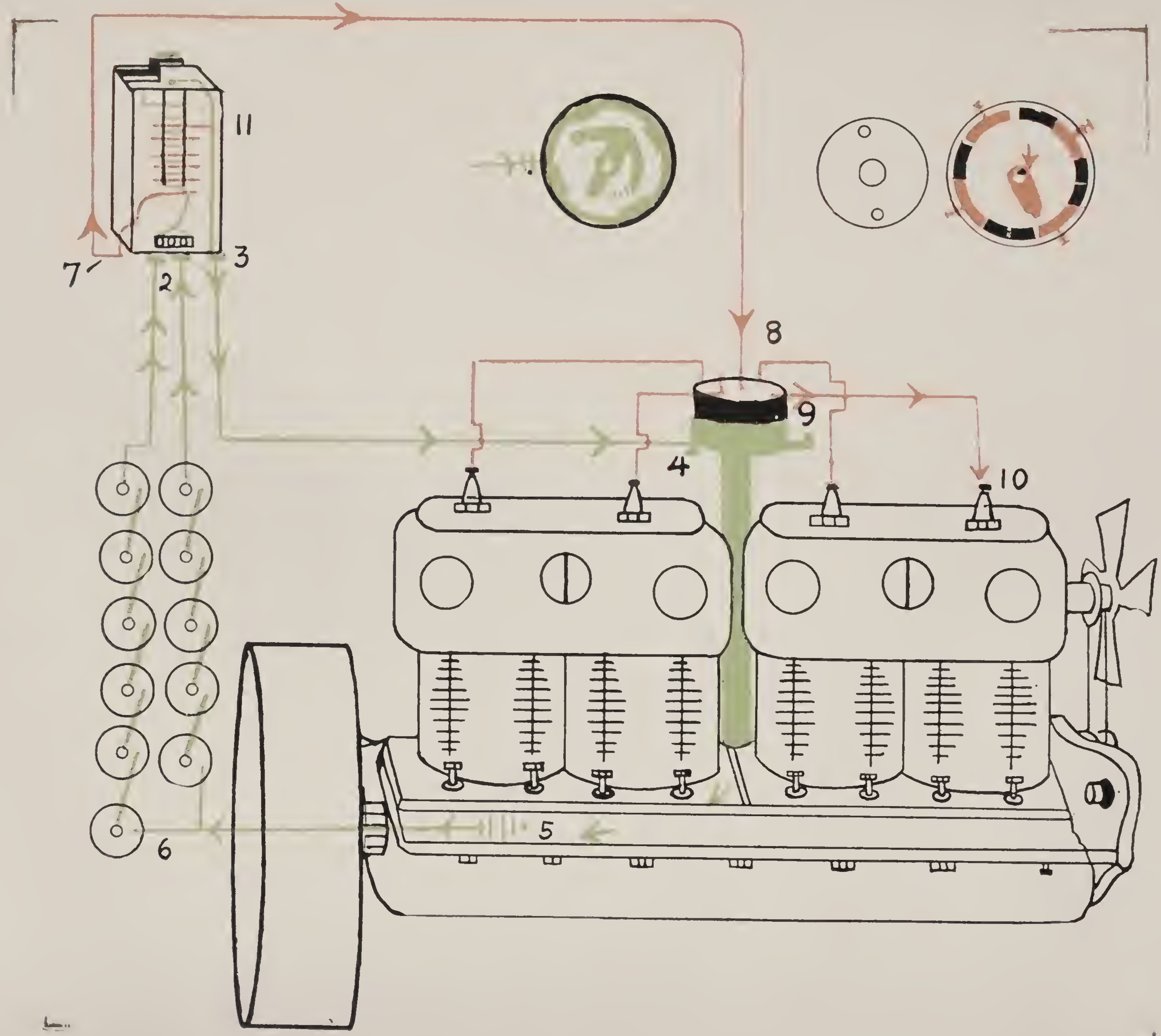


FIG. 26. UNO SPARKER

the next point No. 2 is wired to No. 3; No. 3 is wired to No. 4; and No. 4 is wired to No. 2, making the motor fire 1, 3, 4, 2.

You are now ready to connect the rest of the wires. The high tension wires which lead from the terminal No. 7 of your coil must be connected to the central terminal of the distributer No. 8. Then you will connect your batteries and feed line. Connect the end of the batteries at No. 6 to the ground No. 5. The other end of the batteries to which the primary wires are connected must be connected to the switch terminals at No. 2. Your No. 3 terminal is the lone terminal off by itself which must be connected to No. 4 terminal at the timer. This you will now find is wired up ready for the current to pass over. The current will leave the batteries when the switch is placed in. Passing from the batteries through the switch, it passes over the primary wire which is the green wire through the adjustment screw, across the spring down over the primary feed line, No. 3, to No. 4, where it passes down through the shaft and the frame of the motor, running over to the ground wire, No. 5, and running back to the batteries, No. 6, from which it started.

While this current is passing through the coil, it creates a line of force, drawing the spring down and breaking the current. It breaks the line of force and creates a high tension current in the secondary winding that passes out over the red wire at the terminal No. 7 and passes over the wiring in the direction the arrow is pointing to terminal No. 8. There it crosses over your distributer brush to terminal No. 9 where it passes from this terminal to No. 10, the spark plug, whence it returns from this over the frame of the motor to the green shaft. There it passes up over the green shaft into the contact-maker in the timer, whence it passes out over the green wire and returns up to the terminal, No. 3, passing up to No. 11, where you will notice the primary wire and secondary wire are connected together. There it returns back into the secondary winding, where it started from.

The same thing takes place on this system that takes places on the others as far as the operation of the motor—first No. 1 operating, then No. 3, then No. 4 and then No. 2.

At each time the current flows through this coil, you will find that there is a line of force created. A high tension current is produced from the breaking of the lines of force and passes to the center of the distributer at No. 8. There it is carried off first to the No. 1 point, which you will find is marked 9 to 10, and from this the next time it will pass to No. 2, for the high tension current will be carried to the center of the distributer and distributed off to the next point, and so on around. As these points come in rotation, you must make a change from your distributer to your spark plugs carrying your current to your cylinders according to the way the cylinder fires.

TROUBLES OF THE UNO SPARKER

Should you have any trouble on a Uno Sparker, you will discover that it is very easy to locate the trouble, provided you remember the sounds which you receive from your motor during the time it is stopping. You will find there exists a continual buzz from this system, and the motor will stop running at once, causing back firing in the carburetor while it is stopping. This trouble will be located between terminal No. 3 and terminal No. 4, at the timer or in the timer, which is a short. This causes a continual flow of current to be carried to each and every cylinder. Every time that the gas is being drawn into the cylinder, the gas is ignited too early and will cause the motor to choke down, backfire and stop. Hearing that your coil is continually buzzing, you will know where the trouble is at once.

Should you get a current off of two plugs at the same time, you will find that it will cause misfiring. This trouble is caused from dirt gathering in the distributer to pass out over two terminals at once. This can be removed very easily by taking the distributer off and washing it out. This trouble, though, seldom happens.

Should you be driving along and your motor stops suddenly, not even a sound being heard from it, you will find that the high tension wire has come off of the center of the distributer at No. 8, from which the high tension current has no place to return back over the frame of the motor, and yet it does so. But the high tension current not now being carried to the plugs will cause no more explosions after the instant it leaves its terminal.

You will find that if your ground wire was to come off and land in the clear where it could not touch the frame of the motor whatever, the motor would stop at once. But if it didn't, if your batteries would disconnect, or it may be, cause the motor to miss while it is shaking round over the frame of the motor until it has come to some point of grease or far enough away from the motor until the motor once stops, it is then impossible to start the motor again until it is connected. This trouble can be located by going to your batteries and seeing if you have got a good spark. Close your circuit at the batteries. Finding your batteries are strong and in good shape, then go to work and turn your timer so it stands on contact and see if you get a buzz. If not, you will find that the trouble must be your ground wire is disconnected, or the wire leading from the batteries to the switch.

If these batteries become weak, or even loose connections, or oil-soaked wire, or broken insulation at their connections will cause the same trouble as that on the other systems we have gone over, in which you will have compression, spark and gas, but the motor will not run. The trouble can be located by priming the cylinders to see whether the spark is hot enough to ignite the gas, knowing first, of course, that you have got gas in the cylinders.

MAGNETO

Having finished the vibrating coils, we next take up the magneto. The magneto system runs a little bit different from the systems which we have been reading over, although you will find that the Uno Sparker, as far as distributing the high tension current is concerned, distributes it just exactly the same as it does on the magneto. The new principles that we have to take up is adding to what you have gone over.

If you study carefully at the beginning, getting the principle of your motor and the principle of the wiring system as far as you have gone, you will find that you have got the principle of these systems as far as finding out the way the motor fires and finding the compression stroke dead center. This has got to be done the same on any ignition system that may be used on a gasoline engine.

In taking up the magneto it is really necessary to understand how the current is generated in a magneto. You will discover that the magneto has magnets which have been magnetized by a line of force passing through the iron bar. These iron bars which are bent in a U-shape and made of steel, contain their magnetism. Any soft metal which is nealed (meaning that it is soft material) will not contain magnetism. Such cores as these, you will find used on vibrating or on unvibrating coils, or any coil that is used for induction coils. The steel magnets which are used upon a magneto must be magnetized whenever they become weak; hence it is necessary that you should know the principle of re-magnetizing the magnets themselves.

As you will study this view over carefully, which is set forth in Figure 38, you will see the principle of magnet bars and how they are made for recharging magnets. This view shows you two bars which should be one and one-half inches thick, and twelve inches long, with an iron washer at each end. You will then wind them with No. 12, double insulated magnet wire. Place twelve windings on each core in the direction you notice the lines are wound from this. One must be wound one way and the other wound the other. This gives you a north and south pole, which winding is then connected to the set of lights wired in parallel as you see them here. These lights, which are 32-candle power, can be wired as you see them, and the switch or connections can be made so that the connections of the line above can be connected at any time, as this line above represents the overhead line of your electric current, since we use a direct current for re-magnetizing a 110. You will find by connecting this up as you see it with the number of winds that I have just mentioned, you will have a pair of magnets that would raise about 600 pounds.

When placing the magnet on the top, as you see it here, turn on the lights one at a time. This will bring your amperage up slowly. Each 32-candle power will give you one amperage. Using 10 lights (you should not use any more than this) gives you 10 amperage. This gives you a heavy enough line of force to fill a magnet of this size winding in a very few minutes.

While this magnet is placed as you see it, then with a brass hammer tap it on the inside and the outside. You will find that at the bottom of these two bars you have a block of iron into which the two are screwed and should be about one inch thick and about four inches wide. This completes your yoke. When this magneto is placed on top and is struck with a brass hammer, it jars the metal of the magnet and allows the pores of the metal to turn in one direction, in which the magnet field will fill up to the top.

The magnet bars after being filled will lift about 25 pounds. When you have a magnet so that it will raise this weight when the current is turned off, you will find that it is as full as you possibly can fill it.

These lights must be turned out one at a time the same as they were turned on before taking your magnet off. By turning them all out at once you are liable to blow fuses, and also liable to burn out your meter. You should use only ten lights at 32-candle power each, as the electric light company is liable to kick if they find you using more than this.

These lines of force that have passed up through the magnet leave it magnetized. Then you have what is called a magnet, and you must understand that you have a line of force which passes from the north pole to the south. This line of force which is passing through must next pass through an armature. You will find the magnets of a magneto must be set on in parallel; that is, the north pole must all be placed on one side, and the south pole must be all placed on one side. This puts the line of force then from north to south. You may ask, "Why?" If you were to put a south pole to a north pole, you will find that you would have a line of force passing round the loop and not passing across. It would pass from the north to the south and back up over the top of the magnet through to the north and back to the south and back over again, and vice versa. The line of force working in that way would do you no good. It would be impossible for you to generate a current.

As I have told you in the other systems, we must break the lines of force before we can create a high tension current or create any current at all. Therefore, by placing the north poles all on one side and the south poles all on the other, you will have the line of force passing through the armatures. Then you will find you have a winding made on the armature which this line of force is passing through. While the armature is running at a high rate of speed, it will cut the lines of force and cause a low current to start in this winding, that is, through the breaking or cutting of the lines of force by the armature. Otherwise, if your lines of force were not passing across this armature, you would not have any way of starting another current.

A very simple way of telling whether you have your magnets placed on your magneto right or not, is, before placing them on, to place the points of them together. If they lapel against each other they are right, as you will find the north pole will lapel against the north pole and the south pole will lapel against the south pole. When you have them placed together wrong, they will attract, drawing together and sticking tight and it will be hard to pull them apart. In this instance you have them together wrong and they would not work if placed on your magneto in this way. Another way that you could tell is by taking a small compass. The needle that always points to the north will point to your north pole, and the other end of the needle points to the south pole. In this way you can find which is north and which is south. By placing all the "norths" on one side and setting them in the magneto you have them so that they will do their work properly.

Another caution: Do not set a magneto on iron. It must be set on some non-conductor such as aluminum, fibre, brass, copper, or something of that sort which cannot be magnetized. You may ask, "Why?" For the simple reason, as I hinted to you a few minutes ago, you will find that your lines of force from your magnet bars, instead of passing through your armature, will pass down through this

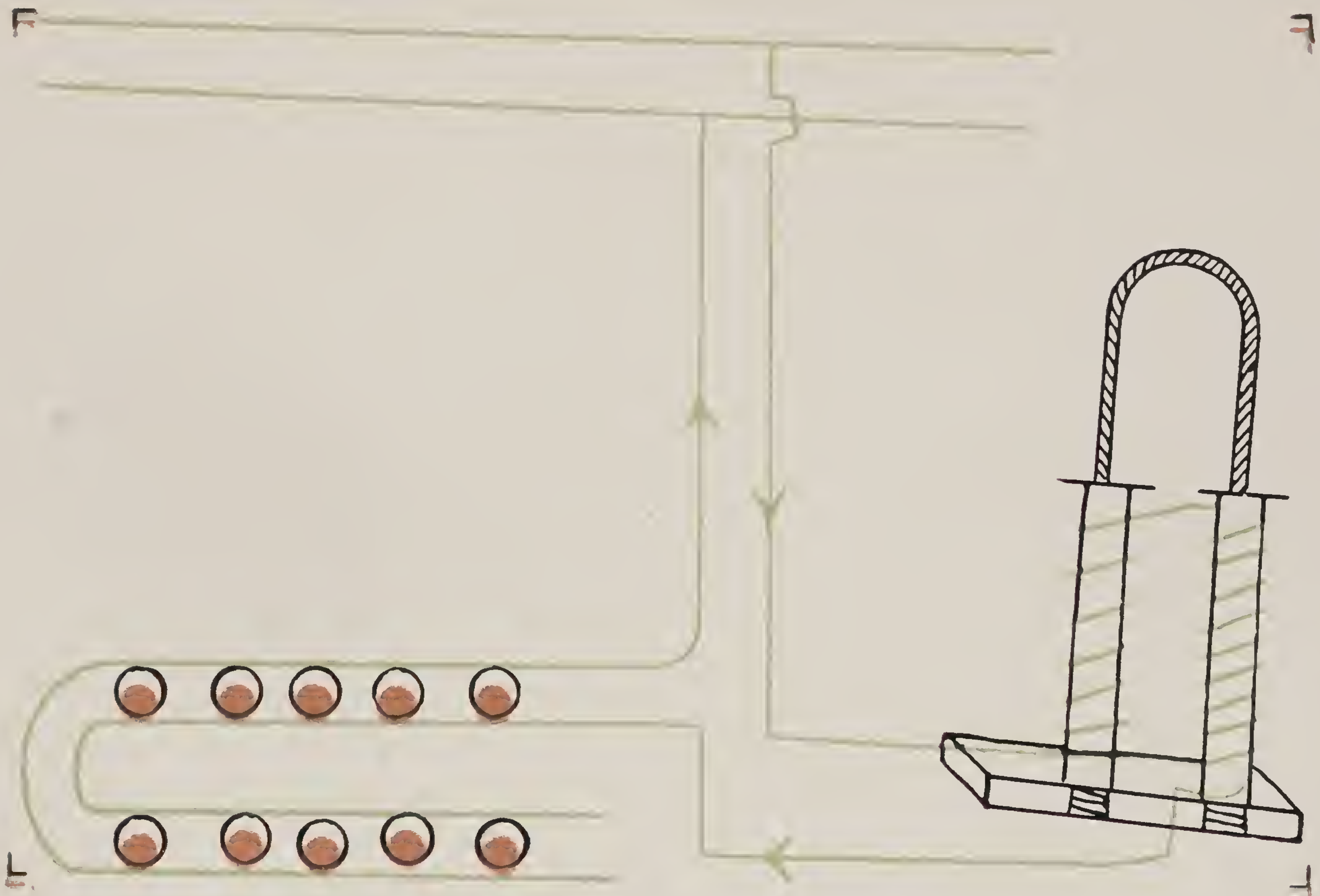


FIG. 38. MAGNET CHARGER.

iron below. Passing through the iron below, it is not passing through the armature and for that reason cannot be cut or broken. If you don't break your lines of force you cannot create a current, so by placing it on some non-conductor you will find your lines of force will pass through your armature, and therefore, it will be broken and produce you another current.

All systems that generate a current such as used on a gasoline engine work on the same principle. The generator, the low tension magneto and the high tension magneto, all generate their currents the same. The only difference is that a low tension magneto feeds through a coil box of its own. A high tension magneto has a double winding on its armatures and generates a high tension current from the mag itself.

THE REMY MAGNETO

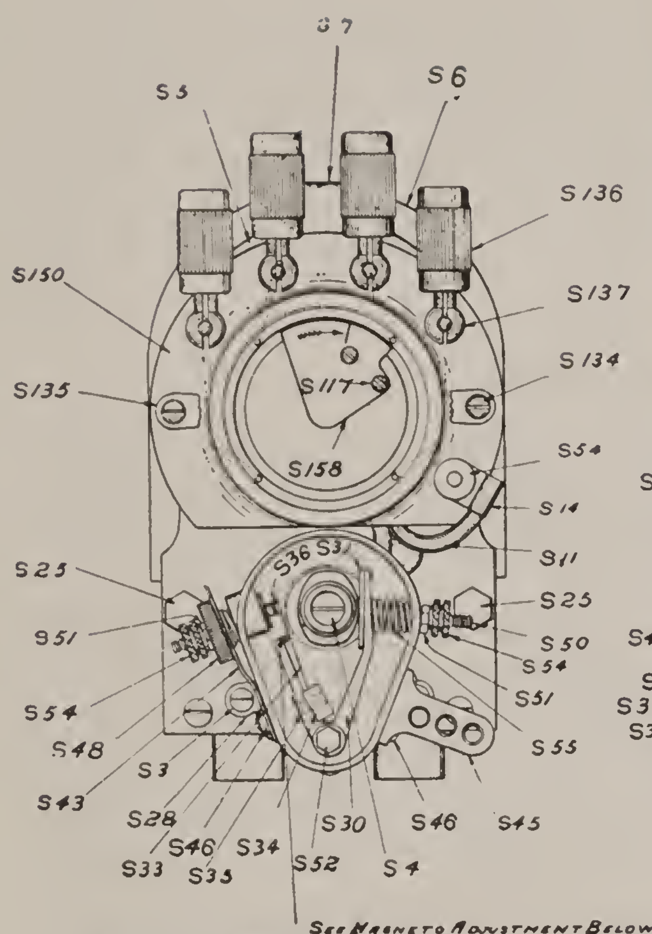
As I now believe you understand the way the current is started in a generator magneto, I can take you to the view of the Remy magneto, Figure 27, in which I will be able to explain the principle of this without any trouble.

The Remy system shows you a system that is made a great deal different than the most of the systems; but its working principle is absolutely the same, since it comes under Seldom's patents. All ignition systems, you will find, that were made under Seldom's patents, work on the same principles. The Ford magneto is the only magneto made that doesn't come under the Seldom's patents, and it is a magneto in the fly wheel.

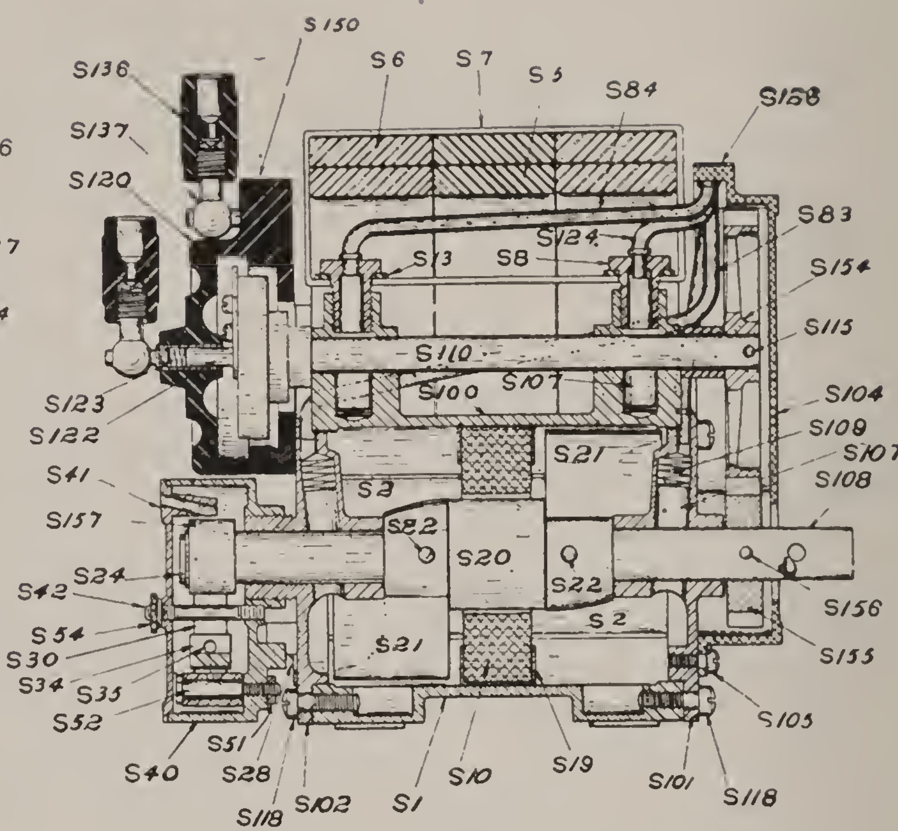
The system shown here has a stationary winding at Figure No. 18. This winding does not revolve, but stands still and has two drop forged cups that revolve by the winding, throwing the lines of force in one direction and then the other. This cutting the lines of force first one way and then the other, causes a low current to start in this winding that passes out through the coil and returns back again from whence it started.

No. 6 shows the adjustment screw which is an insulated screw which both currents have to pass through, where the current is broken when passing this point. No. 5 shows the breaker arm, which is thrown over by No. 13, the cam, which throws the two points apart at No. 6. No. 7 is a yellow wire, which is shown here in a black color. No. 16 is the condensor. No. 3 is a resistance coil. No. 14 is the secondary winding and No. 8, the black wire, the primary winding. No. 12 is the dry cells. No. 15 is the distributor.

Now, we will first set our magneto ready to put it on the car. The first thing to be done is to find out the way the motor fires, which is done by watching the exhaust valve of No. 1 cylinder open and close, and then watch 2 and 3. If 3 should operate next, it shows the motor fires 1, 3, 4, 2 and if 2 should operate next, it shows the motor fires 1, 2, 4, 3. In case the motor fires 1, 2, 4, 3, then the next thing is to find compression stroke dead center, which is done by watching the exhaust valve of No. 1 cylinder open and close and then turning the fly wheel a complete revolution, getting the dead center mark even with the dead center mark on the cylinder; or, it can be done by watching the exhaust valve of No. 4 open and close and



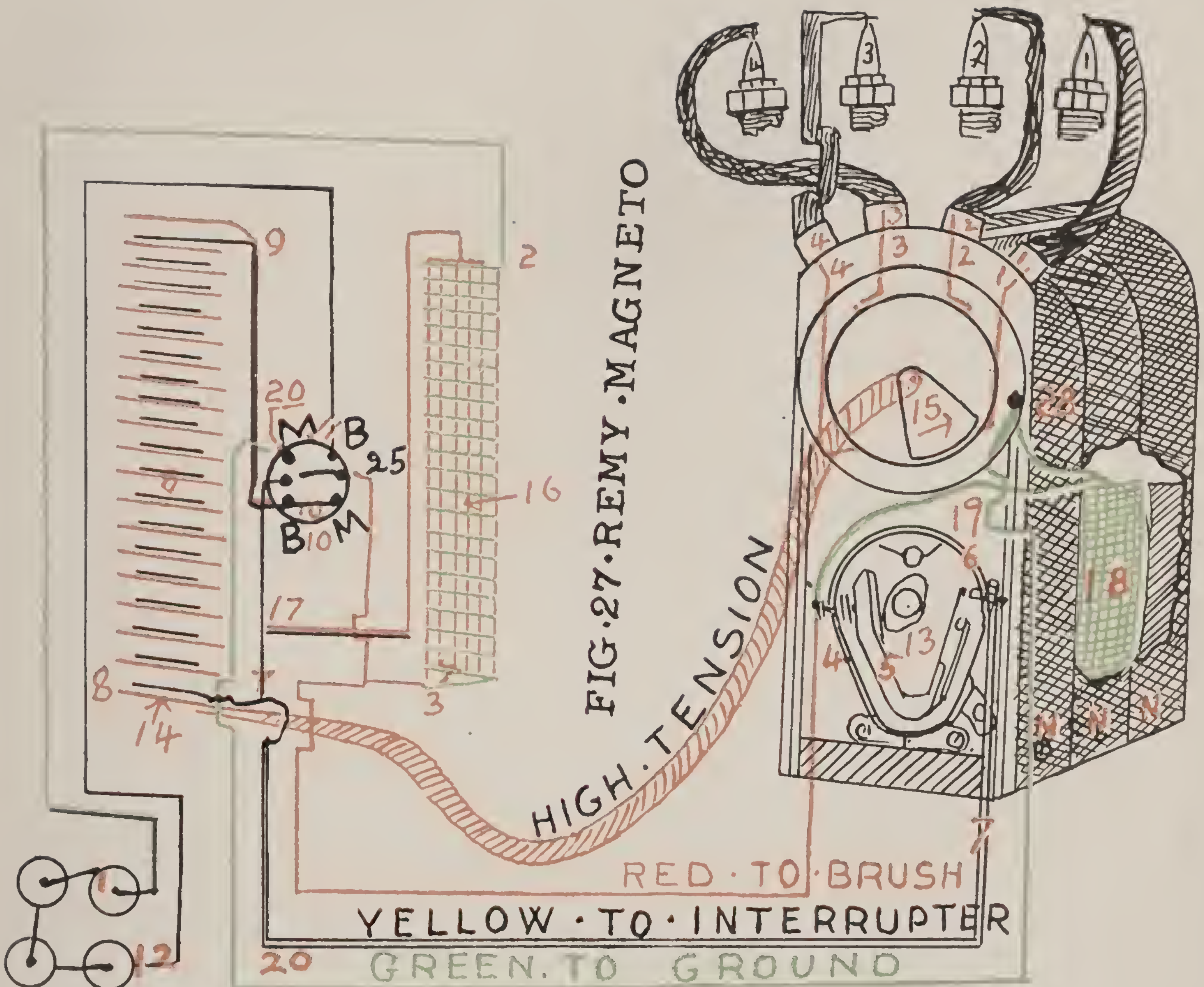
End View of Magneto



Longitudinal Section of Magneto

CONSTRUCTION

S40—Timer Housing for left hand Magneto
S40½—Timer Housing for right hand Magneto
S41—Timer Housing Lid
S25—Hex. Cap Screw
S43—Insulated Screw Clip
S42—Timer Lid Stud
S30—Cam Lever, with hardened steel plate No. S31
S52—Timer Lever Shaft
S55—Lever Coil Spring
S33—Contact Spring, with platinum point No. S36
S34—Cam Lever Spring Block
S35—Cam Lever Spring Block Screw
S48—Contact Screw Insulation, with contact screw No. S47 and platinum point No. S36
S50—Ground Screw
S51—Ground Screw Nut
S54—Binding Nut
S57—Cam for 4 or 6 cylinders (No. S184 for 1, 2 or 3 cylinders)
S 23—Cam Pin
S 24—Cam Plate
S 4—Inductor Shaft Screw
S 45—Timer Shifting Lever
S 46—Shifting Lever Screw
S 49—Shifting Lever Lock Washers
S154—Large Gear for 4 cylinders (No. S174 for 3 or 6 cylinders)
S155—Small Gear for 4 cylinders (No. S175 for 3 or 6 cylinders)
S115—Large Gear Pin
S156—Small Gear Pin
S150—Distributer Case for 4 cylinders (No. S170 for 6 cylinders)
S116—Spacing Collar
S137—Secondary Terminal
S136—Secondary Terminal Insulation
S134—Distributer Lid Spring Screws
S135—Distributer Lid Springs
S133—Distributer Bolts
S120—Distributer Lid with brush-holder No. S121
S122—Carbon Brush
S123—Carbon Brush Spring
S158—Segment
S110—Distributer Shaft with Disc
S101—Drive End Bearing for 3, 4 or 6 cylinders. (No. S185 for 1 or 2 cylinders)
S102—Timer End Bearing for 3, 4 or 6 cylinders. (No. S186 for 1 or 2 cylinders)
S126—Oiler Name Plate
S 83—Long Oiler Tube
S 81—Oil Wick
S109—Wick Spring
S118—End Bearing Screws
S104—Gear Case
S105—Gear Case Screws
S 28—Timer Stop
S 3—Timer Stop Screws
S 5—Inside Magnet
S 6—Outside Magnet
S 7—Magnet Clamp Strap
S 8—Magnet Clamp Strap Screws
S 13—Lock Washer for S8



FIG·27·REMY·MAGNETO

getting the dead center mark even with the dead center mark on the cylinder, you will have compression stroke dead. center on No. 1. Then turn the distributor to the segment in which you want to start on, one of the bottom segments either running clockwise or anti-clockwise; this shows the distributor here turning anti-clockwise. When the distributor is set even with this segment, fully retard your interrupter by pulling it in the same direction in which the shaft turns, then set the two points so they are just ready to break; my method is, by turning the adjustmnet screw No. 6 out until the two points separate and then turn them in again until they just touch, then it will be just ready to break. Set the magneto on the base of the machine and fasten it and your mag then is ready to wire. Wire your high tension wires from 1 to 1, from 2 to 2, from 3 to 4 and from 4 to 3, then fasten the high tension wire to the center of the distributer 15. Fasten your red wire to the brush, No. 4, fasten your yellow wire to the interrupter, No. 6, fasten your green wire, the ground wire, to No. 24, fasten the short wire of the coil No. 18 to No. 24, the long wire to No. 4 at the brush. It would make no difference if these two wires for 24 were fastened where 4 is and 4 were fastened where 24 is, because the current will flow either way. Fasten your battery wires 1 to No. 12 which is the zinc and the other to No. 1 which is the carbon.

These dry cells are wired in series from zinc to carbon. The wire which is connected in the switch you have nothing to do with as they are already connected on the inside of the box. Now, the current will flow from this as described. Turning the switch onto the battery from B to B, the current will leave No. 1 passing to No. 2 through the resistant coil, out at No. 3, then over the red wire to the brush No. 4, passing through the breaker arm, No. 5, through the interrupter, No. 6, over the yellow wire, No. 7, back to the winding No. 8, the black winding, passing up at 9, returning to the switch B, No. 10, across to B No. 11, and back to No. 12 to the dry cells from where it started. While it passes through the primary winding, it creates a line of force at the instant the interrupter breaks at No. 6, the current breaks which breaks the lines of force and there is an induced pressure in the secondary winding No. 14, which passes to the center of the distributor No. 15 across to the segment and to the distributor case No. 1, to No. 1 spark plug, back over the frame of the motor to the red wire No. 4, then returns back to No. 3 through the condensor No. 16, back from the top of the condensor to No. 17, to No. 7 through the primary winding to No. 9, and then returns back into the secondary winding, the red wire from where it started. This would cause No. 1 to go down on power stroke while No. 2 would come up compressing and No. 3 would come up exhausting and No. 4 go down taking in a charge. This time the circuit is closed again when the current will flow the same as just stated. The only difference, passing from the distributor No. 15 to No. 2 spark plug back over the frame of the motor to the red wire No. 4 and back into the secondary winding, the same as current just described, which would cause No. 2 to go down on power stroke and No. 3 would go down taking in a charge, No. 4 would come up compressing and No. 1 would come up exhausting. This time we say we turn the switch onto the magneto from

M. to N., then a line of force from the magnet field end passes through the drop forged cup armature to the south fields; in doing so the armature revolves over, breaking the line of force, inducing a low current in the armature winding 18, which flows over the green wire to No. 4, and from No. 4 to the breaker arm No. 5, through the interrupter No. 6 to No. 7, through the primary winding, the black wire No. 8, up to No. 9 to M, No. 10 to N, No. 20, over the green wire No. 20 to No. 24, and back into the winding from where it started, No. 18. This induces a line of force in the primary winding No. 8 which is broken by the cam throwing the breaker arm over at No. 5, breaking the points at point of No. 6, which breaks the line of force at No. 8, inducing a high pressure in the secondary winding No. 14, which passes to the center of the distributor No. 15, is carried to the segment No. 3, to spark plug No. 4, back over the frame of motor to the red wire No. 4, back to No. 3, through the condensor No. 16, back to No. 17, to 7 and through the primary winding No. 8 to No. 9 and back into the secondary winding from where it started. This causes No. 4 to go down on power stroke and No. 1 goes down taking in a charge, No. 2 comes up exhausting, and No. 3 comes up compressing. At that time the circuit is closed and an induced current takes place in the armature winding the same as described, taking the same course, turning again, inducing a high pressure, which passes to No. 15 again, but this time from segment No. 4 to spark plug No. 3, and back over frame to No. 4 red wire, and back into the secondary winding from where it started, as described before. This causes No. 3 to go down on power stroke while No. 4 comes up exhausting, No. 1 comes up compressing and No. 2 goes down taking in a charge.

THE TROUBLES OF THE REMY MAGNETO AND HOW TO LOCATE THEM

If you were to drive your car up to a place and stop for a few minutes and on coming out you would undertake to start your car, which you would start on the batteries, and finding it would fail to start, knowing that your motor was working very nicely before stopping, you would look for your trouble in the batteries—either weak batteries, disconnected batteries, loose connections, or short in the batteries or battery wires.

If you should be driving along and all at once your car would stop, hesitating as it stopped, and you were to crank it again and finding it would start and run on the batteries but would not run on the magneto, you would look for your trouble in the green wire that runs to the coil No. 18 from No. 4. This wire becomes broken through the advancing and retarding of the spark.

Should you be driving along and your motor stopped and you would find that it would fail to start either on the batteries or mag, finding that you could not even get a spark from it, then take off the yellow wire and strike to the frame with the switch turned on the battery. Finding that you do receive a spark, the trouble may be in the adjustment screw that leads into the interrupter being shorted with grease or cracked in shorting through, but if you find you do not receive a spark, the trouble is that the yellow wire is broken, as this is quite often the case, which happens through the advancing and retarding of the spark. You will find also should the red wire break, you would have the same trouble, although you could receive a little spark slightly from your high tension terminal, but not strong enough to ignite gas; that is, on the magneto, but on the battery side you would receive no spark whatever, and it would be very hard even to receive a spark on the magneto side as you would not be able to spin your motor fast enough.

In order to tell if your magnets are weak, you will find that your motor will miss on the magneto running at low speed, but running at fast speed, it will work very well, and less on a hard pull. You will find on the batteries it will work either at low speed or high. This indicates weak magnets, which must be charged, as is explained in your illustration of the charging plant.

You can also tell if your magnets are weak by placing a key on the side of the magnets and if the key will pull almost to the top, your magnets are all right; but if only pulling part way up, it shows that they are weak; also, you can tell by turning the armature. If it has a pull, it shows the magnets are all right, but if it does not, it shows the magnets are weak.

In case you were driving along and your motor would stop suddenly, firing, but the vehicle would still run a short distance, it would indicate that the high tension wire had dropped off and the last spark that would be delivered before the wire fell off would be the last explosion you would hear. If a motor misses on the battery and mag both when running at low speed, and hits good at high speed, it indicates that the gap between the adjustment screw No. 6 is breaking too quick, but if it misses at high speed and hits good at low speed, it shows that the gap is not breaking quick enough. If you notice a hot spark taking place at the points of breaking, continually, it represents that the condensor is burnt out; the induced current in the primary has nothing to take care of it to prevent it from taking place at the point of breaking. Should these wires, that is, colored green, yellow and red, happen to be cut off any time, the way to test them out is by fastening the two wires together at the battery No. 12 and No. 1, then by turning the switch on the battery B to B, strike the colored wires or the wires that are supposed to be colored, on the zinc of the dry cell in the carbon until you find two of them that will spark together. The two that will spark together on the battery will be the yellow wire and the red one. As you know these two wires, one is red and the other is yellow, you do not know which one is red or which is yellow, the third one must be green. Then, turn the switch on the magneto, take the wire that you know what it is, the green one, place it on the battery and strike one of the other two wires with it on the other side of the battery until you find the one that will spark with the green wire. This will be the yellow wire; then the other one is bound to be red.

In order to test out your magneto coil, take the wire loose at No. 4 and No. 24, place one end on the dry cell, strike the other end on the other end of the dry cell; if you receive a big flashy spark, it shows the coil is all right; but if you have a little weak spark, like a battery spark, it shows there is a short in the coil. If you receive no spark whatever, it shows the wire is broken in two.

In taking the magnets off this magneto, you will find on the inside two nuts, which are very hard to get to, and you will have to remove the distributor head and the cover on the back in order to get into them. When removing them it is a good idea to mark your magnets so as to get them back the same, or to be able to know whether somebody else has had them off and put them on wrong. When putting them back, be sure to get the north poles all on the one side as shown marked on the side of the magneto.

THE SPLITDORF MAGNETO

The next view we take up is the Splitdorf magneto, which you will find at figure 28. This system you will find is somewhat different from the majority of ignition systems, especially in the way the current travels over, and will be found a very hard system to get anywhere. This system, you will find, gives a great deal of trouble. The majority of people do not understand where the trouble is often, caused almost always by not understanding the principle of the Splitdorf.

The system has terminals in place of colored wires, but we have here the wire colored so that it makes it easier for you to trace the current through it. You will find the trouble with this system is that it shorts out through the batteries. You will also have more or less trouble inside of the coil, due to its connections inside. After understanding this thoroughly, there is no reason that a person should have any trouble in locating the troubles of the Splitdorf.

First, in place of having a stationary winding on the armature of this system, we have a winding which is made on the armature and revolves with it. You will find the lines of force passing through the armature are passing through the winding. While passing through the winding, the armature, revolving at a high rate of speed, cuts the lines of force and causes a low current to start over the winding. You will also notice that this current feeds up through the center of the shaft. At the piece of steel on the end you will find two brushes wiping against it, where the current is carried from, thence over brushes through terminal No. 4. This point is insulated so that the current must pass through this terminal and cannot go in any other direction. You will find, also, in turning back, the current must pass through the terminal No. 5, in which this is in the interrupter, as the current is broken at this place. This is also insulated, and the current from both systems, the battery and magneto, must pass through this point.

You will find the batteries are connected at the top of the coil, where you will locate two terminals. Also, you will notice that you have at the top at No. 8 a jump gap which the high tension current jumps across, provided the high tension wire comes off. In case the high tension wire comes off, the high tension current must go some place. You will find that the high tension current, in place of going into the winding, and causing harm by burning clear out or breaking it down, passes over the jump gap where it has taken the same course it would have taken had it gone through a spark plug, and then returns to its point of starting.

This system is a little bit different from the Remy as far as timing the magneto in itself, such as the factory times them. This magneto,

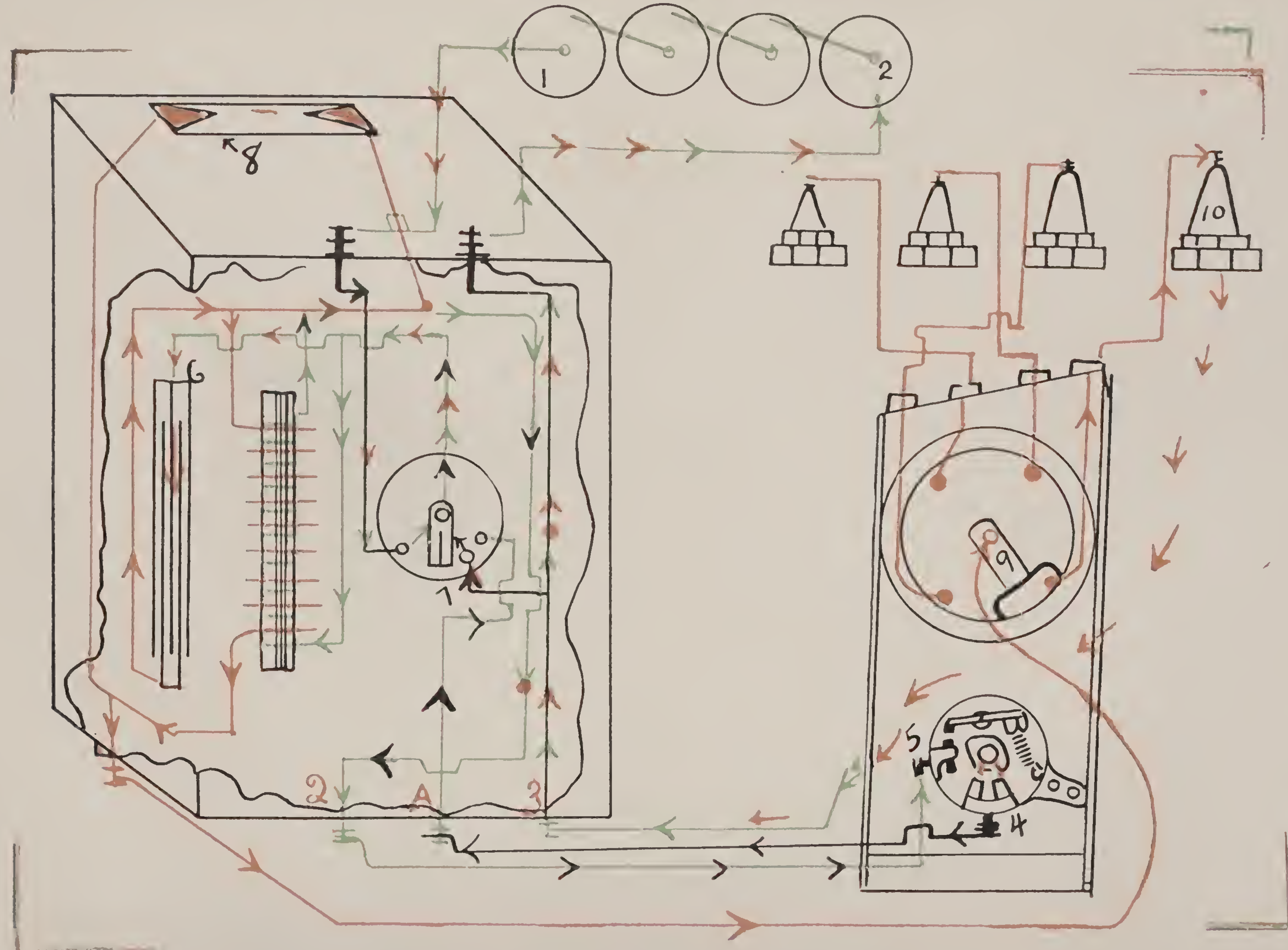


FIG. 28. SPLITDORF MAGNETO

to time it in itself as it is done at the factory, you must set the distributer so it sets between the two brushes. Then set the cam so it sets straight crossways, slip the gears on, and you will find this magneto will be timed in itself. This is so constructed that the distributer will work with the interrupter, or they both will work together, doing their work at the time they should.

To set this magneto on the car is different from timing it in itself You must always remember the first thing to do is to find the way the motor fires, which you now understand from the other facts you have gone over. Then find compression stroke dead center, which is done the same way as on the others. Then set your distributer just ready to break when the interrupter is fully retarded. Next set the magneto in its place, fastening it while the No. 1 cylinder is on compression stroke dead center, and then you are ready to start to wiring up. You wire your high tension wires to the spark plug, according to the way the motor fires, as shown by the red wires. No. 1, you will notice, where the distributer is set, leads to No. 1 spark plugs. You will find that No. 2 leads to No. 3, and No. 3 leads to No. 4, and No. 4 leads to No. 2, making it fire, 1, 3, 4, 2. The high tension wire fastens to the center of the distributer, No. 9.

The primary wires leading to your interrupter are numbered. No. 3 goes to ground, as you will notice; A goes to brush, No. 4; No. 2 goes to interrupter, No. 5. The batteries are wired in series, with one end connected to one terminal at the top of the coil and the other is connected to the other terminal. It makes no difference whether 1 is connected where 2 is, and 2 connected where 1 is, it will work just the same.

Now that we have this system wired up, we shall first trace the current as it passes. First turn the switch to the left, where you have but one terminal. The current then starts out from No. 1 at the batteries, feeding to the terminal at the top, where it passes down over the black wire across the switch, up over the green wire, where it returns down to the bottom of the coil. Thence it returns up over the green winding, where it connects on to the red and passes on over to the green. Then it passes down over the green wire to the terminal, No. 2. From No. 2 it passes to terminal No. 5 and passes through the interrupter, across over the frame of the magneto to the green wire, which is the ground wire, back to terminal No. 3. From No. 3 it passes up over this black wire to the terminal at the top of the coil and returns over the green wire to the batteries, No. 2, from which it started.

While this current is passing through, it creates a line of force through the primary winding. At the time the current is passing through the primary winding at No. 5, it is broken. Being broken, the current breaks the line of force at the coil and creates a high tension current in the secondary winding, which is the red winding. Thence it passes down in the direction the arrow points to the bottom terminal. Passing out over the red wire to the center of the distributer, No. 9, it passes down at the point where the brush is on the distributer up to the spark plug, No. 10, where it returns over the frame of the motor to the green ground wire to No. 3 terminal. Thence it passes up over the black wire to the terminal at the top of the box, where it passes over the green wire, in the direction the red arrows are pointing, to the terminal No. 2 of the batteries, where it passes through the batteries back to the terminal No. 1, in the direction the red arrows are pointing, to the terminal at the top of the box. Then it returns down over the black wire across the switch back over the green wire in the direction the red arrows are pointing, where it passes through the condenser, No. 6. Then it passes out at the bottom of the condenser and returns to the top, where it returns into the secondary winding, from which it started.

Now we will turn the switch on the magneto, having traced the battery current through. You will find that the high tension current takes a different course in returning over the magneto system than it does over the battery system. When the switch is turned upon the magneto, it is turned to the right at the two terminals, closing the circuit on both. The current then starts from the breaking of the lines of force, passing across the magnets. This causes a low current to start in the primary winding of the magneto, passing out at the end of the shaft to the brushes. There it feeds out to terminal No. 4, where it feeds down to the terminal A. From terminal A it feeds up to the switch, feeding across the switch in the direction the black arrows point. It feeds up to the top and then returns to the bottom of the coil, feeding through the primary winding, and back to the top again, where it is connected to the red wire, feeds back over to the green wire, returning in the direction the black arrows point to the bottom terminal, No. 2. Here it feeds over to terminal No. 5 through the interrupter, from which it feeds back inside the magneto, where you will find the other end of the winding on the armature is grounded, returning back into the winding, from which it started.

While this current is passing through the primary winding, it creates a line of force and the line is broken while the current is passing through the interrupter, No. 5. Breaking the lines of force, it creates a high tension current in the secondary winding, which is the red winding, and passing out at the bottom it goes on to the center of the distributer, No. 9. There it passes to the brush on which the distributer is at that time, and thence to the spark plug. Returning over the frame of the motor, it returns to the winding, over the ground wire to No. 3, where it passes up over the black wire to the switch, crossing over the switch. It passes over the green wire in the direction the red arrows point, and passes over to the condenser at the top. It then passes down through the condenser in the direction the red arrow is pointing at the center of the condenser, where it returns to the top and back into the secondary winding, from which it started.

You will notice that this current passes over the lines the same way every time the interrupter comes together and is broken. The high tension current starts and passes over the lines in the same way, only passing to different points at the distributer, where it goes to different spark plugs. It returns in the same way, providing it is running on the same system.

In case the high tension wire should come off, you will find that the high tension current takes place, passing out at the bottom of the coil over the red wire, where it passes up to the top to the jump gap, No. 8, from which it jumps across and returns into the secondary winding, where it started from.

In tracing this current over you will find that the green arrows represent the primary current flowing in the direction that it should flow; the red arrows represent the high tension current flowing in the direction it should flow; the black arrows represent the magneto primary current flowing in the direction it should flow.

TROUBLES OF THE SPLITDORF SYSTEM

If you find that your batteries run down very quickly, it is caused from running a whole lot on the batteries. You are certain to discover that the batteries will not stand up long if you use them a great deal. Another cause of these batteries becoming run down is because they are placed in an iron box on the side of the running board, which makes connections with the frame of the motor in some way. If the zinc of the battery should happen to come in contact with the metal, the current is at liberty to flow over the frame of the motor to the ground wire, No. 5, where it can pass straight through the coil box to the terminal at the top and run back to No. 2. That causes a continual flow of current that causes the batteries to become run down. Sometimes it is caused from the two wires fastening to the terminals at the top being twisted together and becoming oil soaked, allowing the current to flow and thus running down the batteries.

Should you be driving along the road and find your car stops, and the car should run on the batteries but would not run on the magneto, the chances are that your brushes are worn out. The Splitdorf will run on the batteries without brushes, but will not run on the magneto. If your ground wire was to come off it would not run; or if the high tension wire should come off it would not run. If the interrupter was not breaking far enough it would not work properly, and if the platinum were pitted bad it would give trouble such as missing. You will find that if your interrupter should become disconnected from the throttle, your motor would lope.

You can locate and remedy the other troubles of this system the same as on the Remy, which I have explained, except the testing of the wires. You will discover that these wires cannot be tested out in that way, but you will always find the numbers 2, A, and 3, which are wired, as has been mentioned, 2 to the interrupter, A to brush, and 3 to ground.

THE BOSCH HIGH TENSION SYSTEM

The Bosch magneto, you will find, is made somewhat different from the others. The interrupter is made quite a bit different, as the whole works revolve inside of the case. As the breaker passes by the fiber rollers, Y, it forces this breaker foot in F, which breaks the two points apart. In this way you will find the current is broken in this interrupter.

The high tension system, in place of having one winding on the magneto, you will find has two. Here you will notice a heavy and a light line. You will find that one of these lines that is connected to the armature is a primary winding, and the other is a secondary winding.

The low current in this magneto is started the same as it is in any other, through the breaking of the line of force that crosses from one magnet to the other. As this line of force is broken it causes a low current to start in the primary winding, and this passes out to the interrupter, where it returns across the interrupter to an insulated point E and returns into the winding, from which it started. While this current is passing through it creates a line of force through the armature in the opposite direction. This line of force is broken while passing through the breaker H. The current being broken, breaks the line of force which is taking place through the armature from B to B, and creates a high tension current in the secondary winding that passes to the commutator to the back of the machine. Here it passes up over a brush where the line points from K. Then it passes over the jump gap at the top, M. Passing through a carbon brush to the front of the distributer, it then passes through the terminals that the brush is wiping, on out to the high tension wires to the spark plugs, in which it should go. Then it returns back over the frame of the motor and to a brush at the bottom of the magneto, from which it returns into the secondary winding, from which it started.

You will find this system is like any other system as far as timing it and setting it on the car. We have first got to find the way our motor fires and then find the compression stroke dead center on No. 1 cylinder, setting the interrupter just ready to break when the interrupter is fully retarded and the distributer is one-third on in the direction that it is running. This magneto then is ready to set on the car.

To time this magneto in itself, get the distributer as shown in the front view straight between the two contact points on the distributer; then set the insulated block so that it sets straight up and down as shown. Slip the gears on and this magneto will time in itself.

To stop this system from operating, you must use a wire connected to the terminal U. By closing your switch you will find the current from the primary wire which has been produced from the breaking of the lines of force from your magneto passes out through the interrupter to the insulted point D, where it passes up over a connection made at D to the terminal U. Then it passes back over the wire connected to the switch, and crossing the switch returns to the ground, where it returns to the bottom of the magneto, where the brush is wiping against the armature, and returns into the armature into the primary winding, from which it started.

As this current does not pass through the point of breaking, you will find that there has been no high tension current produced because there has been no breaking of the primary current. As the primary current is not broken, and the high tension current not being produced, the motor will stop for the want of a spark at the cylinders. Hence to start a high tension magneto you do not turn the switch on; but to stop it, you turn the switch on and short circuit it.

The jump gap which you see at M is where the high tension current jumps across. The brush that you see where the high tension

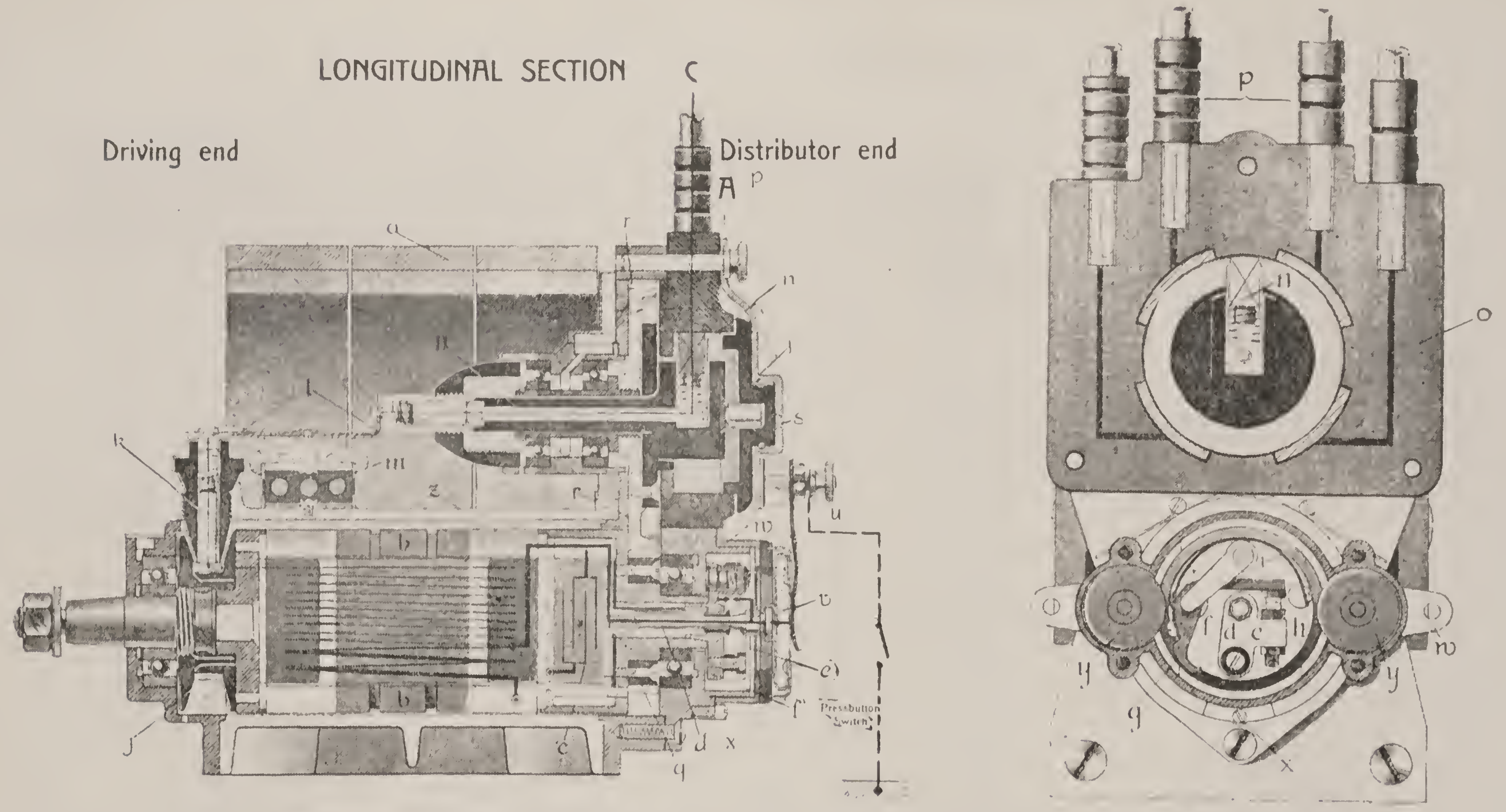


Fig. 39.—Transverse and Longitudinal Cross Section of a Typical High Tension Magneto (Bosch).

a, double magnets with pole shoes; *b*, armature; *c*, condenser; *d*, current carrying screw; *e*, insulated contact piece on contact breaker; *f*, contact breaker disc; *g*, contact breaker lever; *h*, platinum contact; *i*, contact breaker spring; *j*, slip ring; *k*, central carbon holder for high tension; *l*, connection bridge with carbon brush for distributor; *m*, safety spark gap; *n*, rotary distributor piece with square carbon brush; *o*, distributor disc with metal segments; *p*, connection plug for cable; *q*, gear wheel on the armature, *r*, distributor gear wheel with catch plate; *s*, vulcanite cap for distributor disc; *t*, triangular bracket, *u*, binding contact for short circuiting cable with current carrying spring to the end cap; *v*, end cap with carbon and contact spring; *w*, timing lever; *x*, stop screw for timing lever; *y*, fibre rollers for depressing the contact lever; *z*, dust cover.

current feeds through in time becomes greasy and sometimes carries a short off across some other point.

You will find that the brush also at the bottom of this magneto becomes worn out and it is necessary to be replaced with a new one, since the primary circuit must have a tight contact.

Should the wire leading from the terminal U to the switch get shorted, you will find that your magneto would stop generating a current and the car would stop. Being unable to receive a spark from the magneto shows that there is a short somewhere between the interrupter and the point of the current feeding through the interrupter.

If you wish to take this interrupter out, pull off the outer case Y. Then take out the screw D, and you will find the front of the interrupter will come out. This cannot be put back in wrong, as there is a key seat which will not allow it to go in any other way. This makes it very handy in dressing your platinum points.

The condenser which you see at No. 1 is to take care of the current that is created from the breaking of the primary line avoiding a hot spark taking place across the platinum points.

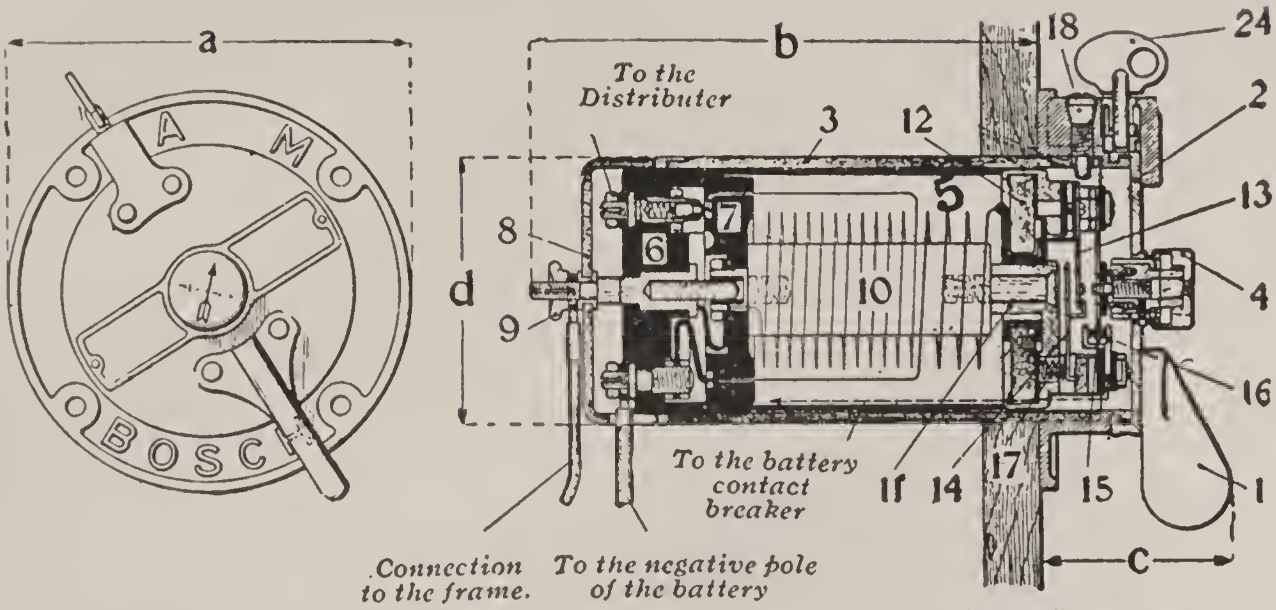
This magneto sometimes becomes shorted badly with grease inside, as it is a high tension magneto, and it takes but a very little grease until the high tension current will travel across, which, with a low tension system you will find is not nearly as apt to short out. In case this happens by going to work and washing your magneto out with a bucket of gasoline, you can remove this trouble without any further delay.

You will notice that if your motor is not working good at low speed and is hard to start on the magneto, the trouble may be that your platinum points are not breaking far enough apart or your magneto may be weak or the brush at the commutator K may be worn out or gone.

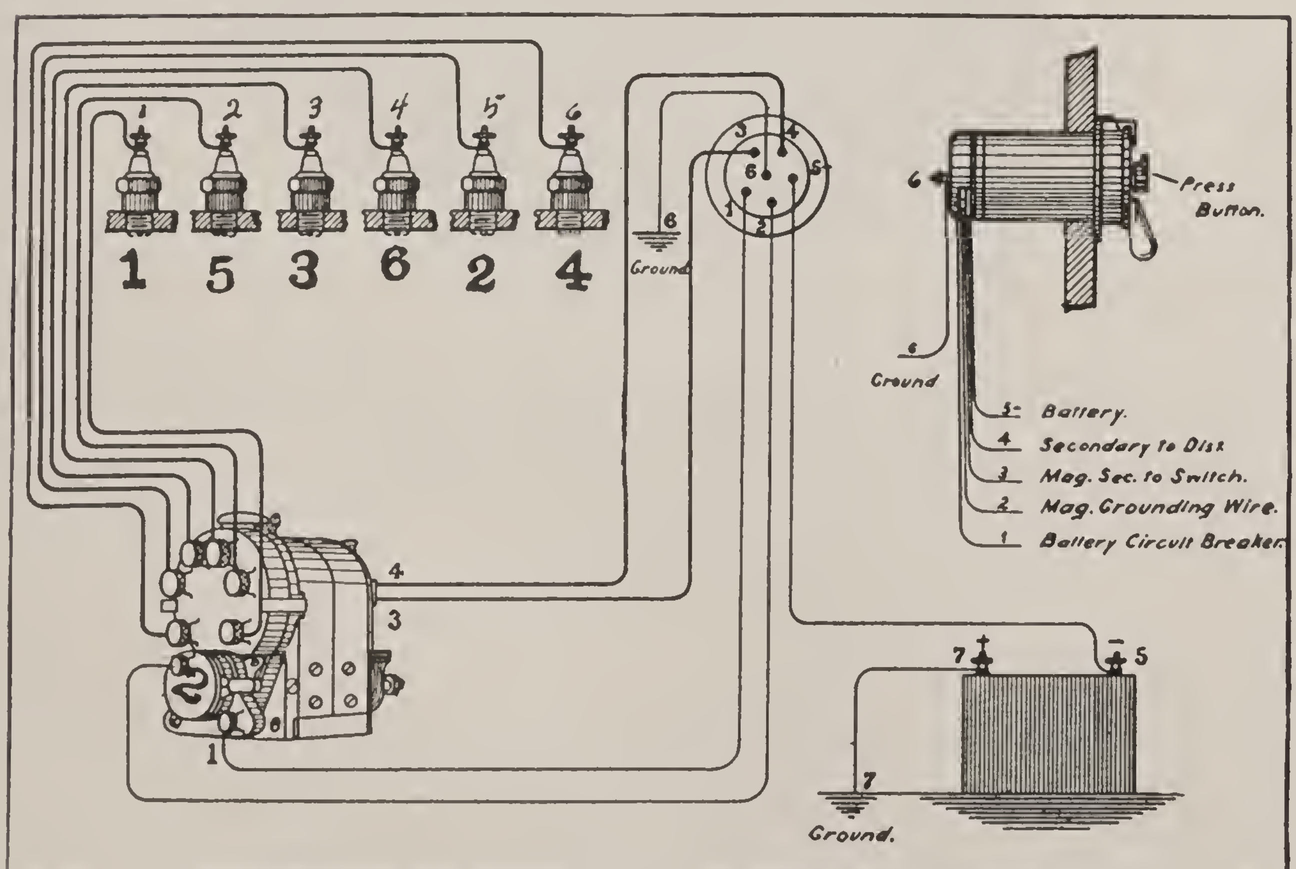
The wiring diagram of the S. R. 6 Dual Bosch system will be found on Figure No. 39, which I can assure you is one of the best ignition systems to be found on the market at any price ranging within its price. It is a system that the faster the motor runs, the hotter the spark is delivered. No matter how high your compression may be, it can not be too high for the Bosch.

The Bosch system is a very simple system and the repairs for the Bosch can be found almost any place they handle any kind of repairs whatever.

The Bosch Dual is a double system up as far as the distributor; you have two complete systems up to this point, a battery system and a magneto system. This is a high tension mag, which delivers high tension current from the mag itself, using a coil in case you want to start your car on the batteries, or if you want to run on the batteries. A great many times you will find that the car will start with its own accord in case it has good compression. With this system you will find by pushing the button, it will vibrate, delivering a hot spark in the cylinder that may be standing on compression, causing it to go down on power stroke, which will even be a saving to your storage battery, even if you have a self-starter in connection. If you do not have a self-starter, nine chances out of ten, your motor will always start off the ignition system providing it has good compression.



1. Switch handle.
2. Movable cover
3. Coil case.
4. Starting press button
6. Fixed connection plate.
7. Movable switch blade
8. Cable cover
9. Milled edged nut.
10. Iron core.
11. Plate carrying the starting arrangement and the condenser
12. Condenser.
13. Contact spring.
14. Trembler
15. } Auxiliary contact
16. } breaker
17. Trembler spring
18. Stop screw for switch handle.
24 Locking key



WIRING DIAGRAM OF THE "ZR6 DUAL SYSTEM

FIG. 39

In wiring this system up, fasten No. 5 to the storage battery, fasten No. 4 to the lead of the induction coil, No. 4 to No. 4 top lead to the distributor, fasten No. 6 to the frame high tension ground wire, fasten No. 3 from the induction coil to No. 3 of the magneto, the high tension lead from magneto to switch on ignition coil. Fasten No. 1 to the ignition interrupter and fasten No. 2 to No. 2 on the mag lead for shorting magneto. Fasten No. 7 to the frame of the motor or ground wire from storage battery.

When starting this system, the switch is turned on the battery, the current leaves the positive point of the storage battery, passing from 7 to 7 on the frame or ground, from there it passes to the interrupter, passing through the interrupter on to the insulated point No. 1, then over the lead wire to No. 1 at the ignition coil, where it passes through the primary winding through the vibrator and back, out at No. 5 to No. 5 at the storage battery. While passing through here, the current causes the iron core inside the induction coil to become magnetized, which attracts the spring, breaking the current or otherwise causing it to vibrate, which breaks the line of force and induces a high pressure in the secondary winding, which passes from No. 4 to No. 4 on the magneto to the distributor, and from the distributor to No. 1, where it passes over the frame of the motor, returning back to No. 6 the ground wire from the ignition coil or high tension return. In this case, it causes your No. 1 to go down on power, where your No. 2 comes up compressing, No. 3 goes down taking in a charge and No. 4 comes up exhausting; where No. 5 would be just finishing exhausting, No. 6 is finishing power. These are the large numbers. Now, turning the switch on the magneto, a line of force from the north pole to the south pole is broken by the revolving of the armature; breaking this line of force induces a low current in the armature winding which passes to the interrupter at No. 2, through the interrupter it returns back into the mag again from where it started. As this circuit is broken at the ignition switch, it can not pass from No. 2 to No. 2 at the ignition switch. As this current is broken, it breaks the line of force, which induces a high pressure in the secondary winding, due to the breaking of the line of force which this current is creating in the armature. This high pressure passes from No. 3 to the ignition switch, through the ignition switch back to No. 4 to the distributor, and from the distributor, it passes to No. 5 spark plug, where it passes back over the frame of the motor into the secondary winding of the armature from where it started, where it is grounded at the bottom of the mag.

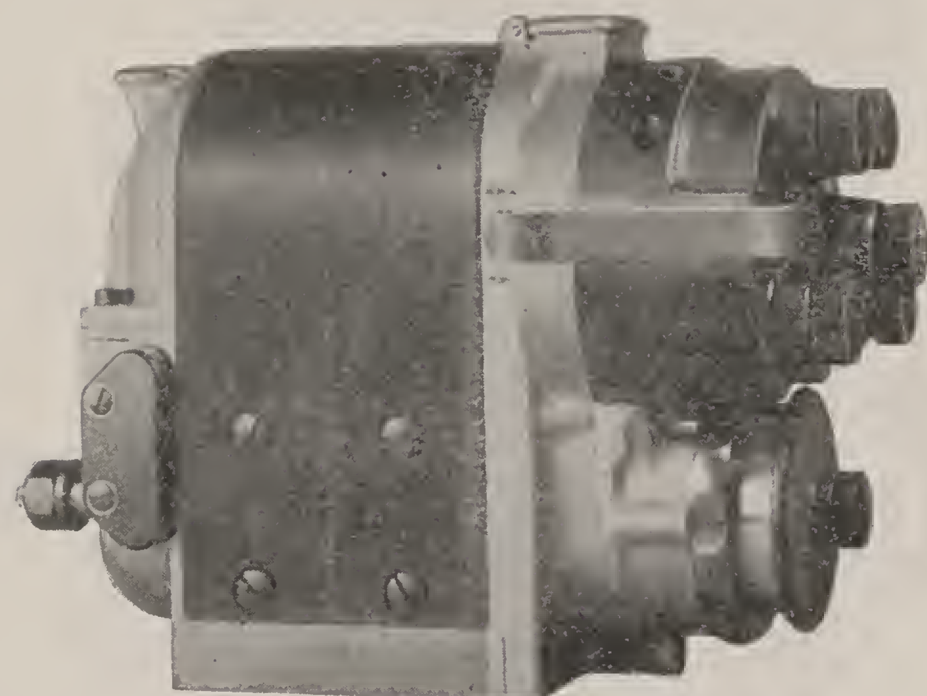


FIGURE NO. 46

Figure No. 46 shows a Bosch high tension magneto as it would look ready to put on the car.

FIG. NO. 40. MEA MAGNETO

Fig. No. 40 shows a Mea magneto, which is one of the standard mags, delivering a very hot spark. You will find that this mag is used on a good number of cars which have a bell magnet. The whole magneto advances and retards. This magneto has been known to deliver a spark just from advancing right quick, because it throws it past the poles, breaking the force through the armature, and at that instant, will induce a current in the primary, and the current going through the primary, through the interrupter and advancing on over, causes the interrupter to break, inducing a high pressure in the secondary winding, which is carried to the distributor and to the spark plug by delivering a spark in this way by advancing the magneto only.

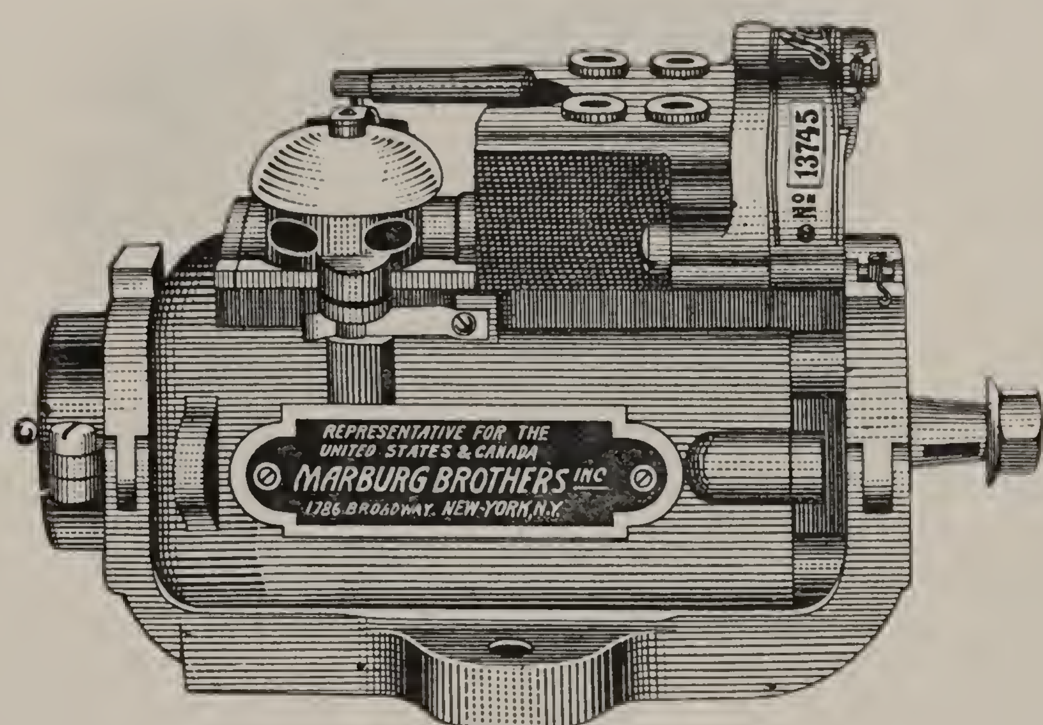
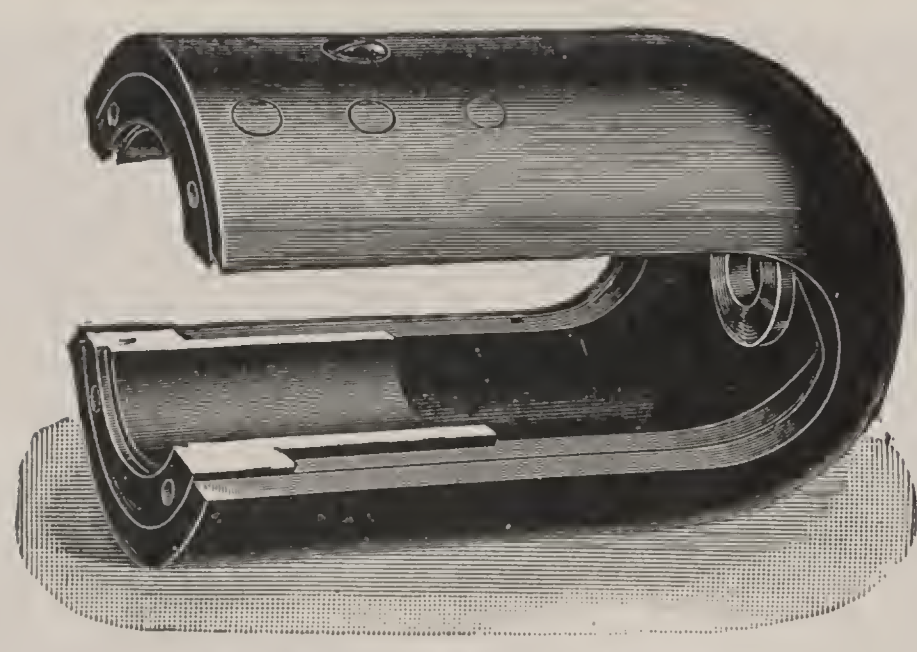


FIGURE NO. 40.

The Mea magneto is very easily set. All that is necessary is to put your No. 1 cylinder on compression; have the magneto fully retarded, turn your distributor until No. 1 shows up at the glass in front of the distributor. The interrupter should be just ready to break, the full distance of the break will be 1-64 of an inch, and then have it just ready to break at this time when No. 1 shows at the glass. Set the magneto on a base and fasten it and it is ready to be wired up, and the high tension wires will wire according to the way the motor fires and then you have your wire to short the mag out when you want to stop it.



THE BELL-SHAPED MAGNET

FIGURE NO. 52

Figure No. 52 shows the bell shaped magnet for a Mea magneto. This magnet works just the same as any other magnet. Lines of force will pass from north to the south pole and can be charged the same as any other magnet.

FIG. 31. THE TRAVEL OF A PISTON

The next thing that we will take up must be the mechanical end of the machinery, as it is necessary to understand the working principle of all the parts of the automobile and their relations.

You will find that valve timing is a very important thing to understand in any line of machinery, it doesn't make any difference whether it be steam or gasoline, and you will find very few who are operating such machinery who understand it thoroughly.

You will discover that the piston travels farther on one quarter than it does on the last, and for that reason the ordinary mechanic doesn't understand valve timing as he should.

Speaking of the piston traveling farther on the first quarter than on the last, at first seems impossible; but it does so, and the illustration No. 31 will prove it to you. To look at this illustration alone, not understanding what it is, it would seem to you a Chinese puzzle,


RAIL ROAD
CROSSING
3468

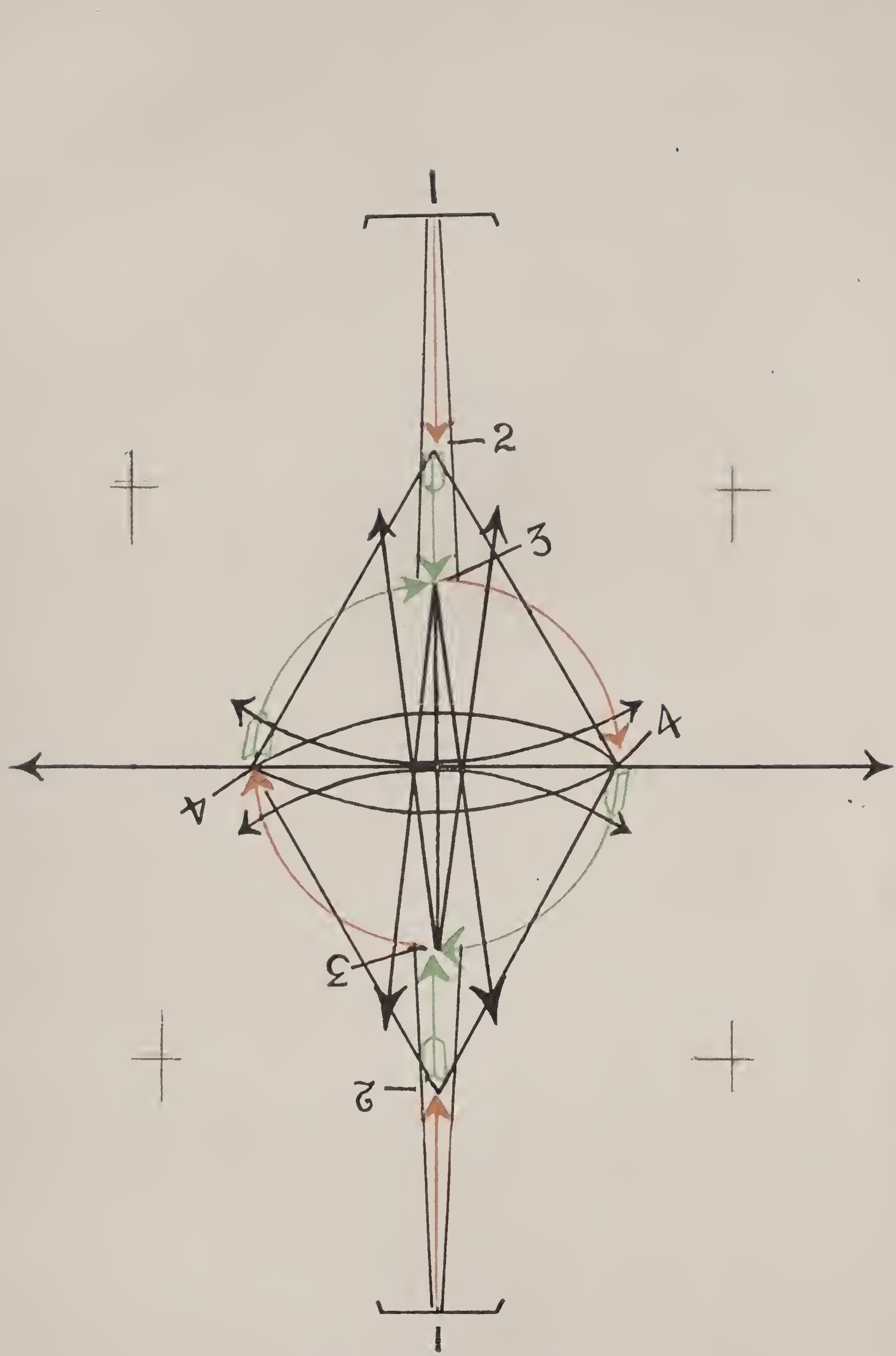


FIG. 31. THE TRAVEL OF A PISTON.

but it proves every point of travel of the piston and also the connecting rod. It is necessary to understand this illustration since you will find that your valves open and close at such points that seem impossible that it should do so, for instance, when the intake valve opens past dead center and closes past the bottom center, and when the exhaust valve closes past the top dead center and opens before reaching bottom dead center. When understanding the principle of the over-travel, you will plainly see why these valves open and close at these points.

Figure No. 31 shows a double-hosed engine and its outward travel and its inward travel. No. 1 shows the piston at each end; No. 2 shows where the piston has traveled on the first quarter—the red mark coming from No. 1 to 2. No. 3 shows where the crank has moved from the dead center to the first quarter, No. 4, showing you the travel of the first quarter. Then the green arrow shows you the crank traveling from No. 4 to No. 3 at the bottom. This shows the second travel of the crank, and the green arrow from No. 2 to 3 gives the travel of the piston, showing that this travel is much shorter than the first. The black mark swung from 4 to No. 4 shows the over-travel as if the crank box was taken apart. You would find that your connecting rod will not swing on this line as it curves from 4 to 4. The lines running in the diamond shape from the center shows the actual rockby past dead center. At this point you will find that the piston does not move a particle while the connecting rod is moving across this space.

You will also observe that there is a drop from No. 4 to No. 3. For instance, to prove this out, go to work and make a circle with your pencil on a piece of paper, measuring the distance across the circle. Then make a mark the same distance above the circle as No. 1 shows you here. Then place a line straight through the center of your circle as the line is drawn here with the red and green arrows; then place two pencils with a piece of string just the length of the mark at the top to the circle, and move the pencil at the circle to the first quarter, drawing your pencil at the top downward and only reaching the first quarter. Then move the pencil at the top backward and forward to make a mark. Then move from the first quarter to the second quarter and still pulling your pencil straight downward, you will see for yourself how the piston travels farther on the first quarter than it does on the last.

You may ask, "What does this amount to?" It means that it is impossible to find the exact dead center of a flywheel without the means of a triam. You will find that the rockby throws you off one way or the other, and this illustration proves that to you. You may have your piston at the highest point and still the connecting rod be a little off one way or the other. This would throw you off on degrees. The degree marks which you set your valves by must be absolutely right, and those marks are measured from the exact dead center. If you do not have the exact dead center it would be impossible to have the proper degree marks for the exhaust valve to close and the intake valve to open.

The next figure which I shall explain to you will be showing you the valve timing as it is done, showing you the view of three that represent only a T head motor. The first cylinder is showing you the cams and cam gears, the push rods and valve stems. You will find in Figure No. 30 that it shows you the three cylinders, representing the one with red numbers and also black numbers. The red numbers represent the first to the last thing that you are to do, following these numbers in rotation as they run, and you will find that you will follow valve-timing as it should be done.

You will find that No. 2 is pointing to a mechanical rule, and that No. 7 is pointing to the degrees of a circle. You will also notice that No. 5 is pointing to a triam and No. 8 is placed upon the piston. No. 10 shows a business card between the push rod and the valve stem. No. 6 shows the connecting rod with an arrow just below it pointing at the exact dead center. No. 11 shows the exhaust cam and No. 12 shows the intake cam. No. 9 shows the exhaust on cam gear and the intake cam gear.

In order to do valve timing it is necessary to find the exact dead center of your flywheel. In order to do this, this illustration will show you plainly how it is done. We will first proceed starting in to find the exact dead center. First remove some plug or other at the head of the cylinder, by which there is always a way to get in the head of a cylinder. After removing the object which may be placed at the head, place a mechanical rule in the head of the cylinder, as we have at No. 1, which is the first thing to do. Raise the piston then, until the rule raises up as high as it will possibly come. Then notice the distance that the rule sets in. Drop this rule one-quarter of an inch lower than the distance at which it stands. That throws your connecting rod over to one side as No. 1 in the center of the flywheel shows you. Now go to work and place a triam at the lowest point of the flywheel, as No. 2 shows you, placing this at the lower point of the flywheel. Make a counter punch mark on the frame of the motor and place the other end of the triam in the counter punch mark. Make a temporary mark on the flywheel where the triam touches. Next raise the piston back up to its highest point, and drop it on the other side the same distance as No. 3 shows you at the head of the cylinder, one-quarter of an inch. Place your triam back to the same counter punch mark on the frame of the motor and put the triam at the lowest point of the fly-wheel, as No. 3, at the bottom, shows. Make another temporary mark. Take your mechanical rule and measure the difference between these two marks. Make a counter punch mark square in the center between the two. This gives you the exact dead center of the two marks. Now turn the flywheel back until the triam will touch in the counter punch mark on the frame of the motor and in the counter punch marks between the two temporary marks, as No. 5 shows you. This will give you what is called "triam dead center." After you have done this and while the motor is standing in just this position place a mark across the face of the flywheel and a mark on the cylinder to correspond with it, as No. 6 shows you. This gives you exact dead center.

Now, if you wish to place another dead center on the other side for 2 and 3, you may do so by measuring the distance around your wheel. Finding this wheel is 60 inches around, or whatever it may be, take one-half of the distance. Say it is a 60-inch wheel—you will

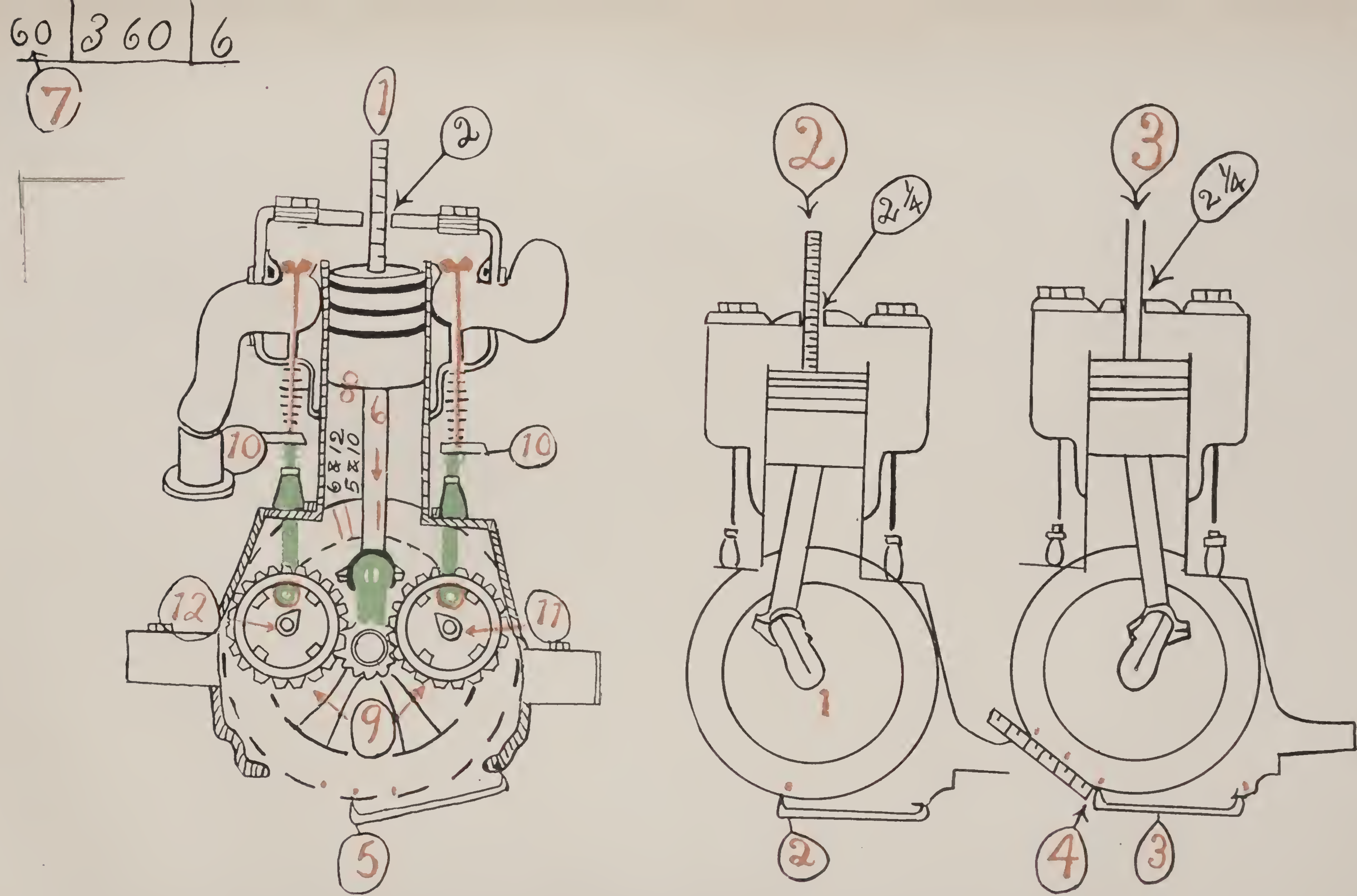


FIG. 30. VALVE TIMING

measure 30 inches from the dead center mark, which will give you exact dead center on the other side. This will be the dead center for 2 and 3. The first dead center is 1 and 4.

After you have this dead center mark, you then have a mark to locate the degree mark from, which is exact. To get the degree of this flywheel, measure the distance around the wheel. Whatever it may be, it must go into 360. We will say that it is a 60-inch flywheel. Sixty goes into 360 six times, giving you six degrees to one inch, or the sixth of an inch to one degree. Then measure the degree marks from the dead center mark back at which you will find the exhaust valve closes between 5 and 10 and the intake opens between 6 and 12, as figure No. 8 shows. You will ask, "How is this?" It is enough to answer that this has been figured out by experts who have figured valve timing of all motors. There are no two motors of which the valve timing is the same, but there is no motor made but the exhaust valve closes some place between 5 and 10 degrees and the intake opens somewhere between 6 and 12. Hence, to get the average, we must do the same as a jewelryman does regulating a watch. We can find the center. We know that we have got to go to 5, and half of 5 is 2½; added to 5 gives you 7½. That would be 7½ degrees then at the average. The intake opening is between 6 and 12, so that we know we have got to go 6 and somewheres between 6 and 12. Half of 6 is 3 added to 6 gives 9, and hence 9 is the average. Now, we say we take the average and measure 7½ degrees from dead center mark, as the two marks back of the dead center mark shows you the degree marks. We will first place the exhaust closing, which is between 5 and 10, on 7½, which is 1¼ inches. Now, the intake opens between 6 and 12. Finding the average to be 9, which 9 degrees at 6 degrees to an inch is 1½ inches. Measuring 1¼ back, or the 1½ for the two marks, we locate the exhaust closing and the intaking opening.

Now you are ready to do valve timing just the same as you will find a great many motors already marked as they leave the factory, although you will discover a number of motors placed on the market that were never marked. In case you were to go up against one of those unmarked motors, and someone had had the gears off, and had had the valve timing off, and suppose you were asked to fix it; it would be a "big white feather in your cap" if you were able to go ahead and do the valve timing, correcting and making the motor give the same power that it did the day it left the factory, which thing you can do if you follow the illustration shown.

From this point we must pass on to do the valve timing as it is done on all motors, following after the red figures as they are on the illustration. First, after this, we will pass to No. 9, showing you the two gears, which means that they must be taken off in order to allow the cams to drop down as far as possible—that is, to allow the push rods to come down as far as they can. No. 10 shows you that the adjustment made between the push rod and the valve stem must be made just the distance of a business card, which is about the 64th of an inch thick. You will find by two adjustment nuts on the push rod you can make this adjustment to that distance. You may ask, "Why not have them so they just touch?" The reason is this: anything running at a high speed has vibration, and if you were to bring them up so they touch the motor running at a high rate of speed would not allow the valve to close, since the vibration of the push rods would hold the valves just a fraction open, causing backfiring through the carburetor and backfiring in the muffler. The valves must then have clearness enough to allow for this vibration so that the valves may seat each time. Notice there are springs above the business card which pull the valve down tight each time.

After you have made this adjustment, you are now ready to start in to set your cams. Turn the first mark, which is the exhaust closing between 5 and 10, even with the dead center mark on the cylinder. Then turn the exhaust cam up No. 11 until it raises the push rod against the valve stem and is just ready to leave it, and place your gear on the exhaust cam shaft. Then turn the intake degree mark even with the center of the cylinder, which is between 6 and 12, and turn the intake cam up until it raises the push rod against the stem ready to open it, and slip the intake cam gear on. This is No. 12.

Now you have the valve timing done, and you are ready to place your case on and try your motor out. If you follow this through as I have indicated, there is no chance for you to ever make a mistake.

You may ask, "What is a triam?" The figure just below No. 5 shows you a triam. It is a rod cut fifteen inches long and has each end sharpened to a point where each end can then be bent one inch, leaving you a 13-inch triam. It is used on steam and gasoline engines to find the exact dead center of the flywheel.

In case that you were to grind a set of valves, you will find that it is necessary to adjust your valve rods so that you can slip a business card between each one. To do this, first put No. 1 cylinder on compression stroke dead center, which can be done by watching the exhaust valve open and close on No. 4 cylinder, and that gives you compression stroke dead center on No. 1. Then set the exhaust and intake cam on No. 1 cylinder so you can slip a business card between each one. Turn the flywheel then a half a revolution and adjust the two valve rods on the next cylinder that fires the same. Then turn it another half revolution and adjust the valve rods on the next cylinder that fires, and so on until you have adjusted all the valve rods that you may have.

Say that you were to break your cam shaft and had to put on a new set of cams. To do this, place on a T head motor the exhaust cams all on one side, and the intake cams all on the other. In an L head motor you will place the exhaust cam on; then two intake cams; then two exhaust cams; then two intake cams and one exhaust cam, and you are ready to start in. Place the gears on and allow all the cams to turn straight down, allowing the push rods to come down as far as possible. In addition, you must have the degree marks for Nos. 2 and 3, as well as 1 and 4 dead center. Turn the first degree mark, which is the exhaust closing, even with the center of the cylinder on 1 and 4. Then turn the exhaust cam up until it raises the push rod against the stem and tighten the set screw that is found in the bottom of the cam, or must be put there. Next turn your intake opening mark even with the center of the cylinder which is between 6 and 12, and turn the intake cam up until it raises the push rod against the stem and locate the set screw in it. Then turn the flywheel half over, bringing your 2 and 3 dead center mark up. It is up to you now which way you want your motor to fire—whether 1, 2, 4, 3, or 1, 3, 4, 2. You must then turn the 2 and 3 dead center exhaust degree mark even with the center of the cylinder and turn the exhaust cam up until it raises the push rod against the stem with No. 3 cylinder just ready to leave and tighten the set screw in this. Next turn the intake opening mark even with the center of the cylinder and turn the intake cam up until it raises the push rod against the stem so that it is just ready to open on the No. 3 cylinder. Then turn the flywheel half over again, bringing up 1 and 4 dead center. Next the exhaust mark even with the center of the cylinder and turn the exhaust cam up against the push rod on No. 4 cylinder so that it is against the valve stem in a position just ready to leave and tighten the set screw in this. Then turn the intake mark even with the center of the cylinder and turn the intake cam up until it raises the push rod against the stem on No. 4 cylinder, and lighten the set screw in it. No. 4 must always fire after the second cylinder. Now turn the flywheel half a revolution again. Next turn the degree mark even with the center of the cylinder for the exhaust to close and raise the exhaust cam until it raises the push rod against the valve stem on No. 2 cylinder in a position just ready to leave. Then tighten the set screw and turn the intake degree mark up even with the center of the cylinder and then turn the intake cam up until it raises the push rod against the stem ready to open, and tighten the set screw.

Now you are ready to take off the gears and pull out the cam shafts. With a counter punch, make a counter punch mark in the center of each one of these cams. With a drill, drill a hole through the cam and shaft. Then drive a pin that will make a tight fit in the hole and get it in even with the cam. With your counter punch sink this at each end so it cannot work out. Do this to each and every one of your cams and take a file and dress it off smoothly.

Your cams and shaft are now ready to be placed back in the motor. Place the cam shaft back where it belongs and turn up 1 and 4 dead center, bringing the exhaust degree mark even with the center of the cylinder. Turn up the exhaust cam until it raises the push rod against the stem and slip the gear on. Turn the intake degree mark even with the center of the cylinder and then turn the intake cam up until it raises the push rod against the stem just ready to open and put the gear on and you have your cam shaft and cams timed.

CARBURETORS

The next system we take up will be the carburetors, a very important part of the automobile to understand. In fact, there are very few who understand the principle of a carburetor thoroughly so they can locate their trouble at once.

If you will study this illustration carefully, you will find that you will be able to easily locate the trouble in a carburetor. Very few understand how to adjust a carburetor as it should be. Indeed, very few understand the adjustment principles of the carburetor at all. Very few also understand the color of blaze, the sound, etc. As far as teaching you how to adjust a carburetor is concerned, that I cannot do, nor can any other man living, no more than can you be taught to play a violin. An instructor can teach you the notes, but not to play the music. You will find out what I can teach, and then you will have to learn the music yourself. Often you will hear adjusting a carburetor spoken of as tuning a motor.

The carburetor, you will discover, is not hard to adjust if you once learn the sound of the motor and the color of blaze which you receive, due to different mixtures.

The trouble of carburetors, you will ascertain, is due greatly to the not taking care of the gasoline. A great deal of gasoline is poured into the tanks without being strained. It should be strained through a chamois skin. This will avoid any dirt from passing through, and also will avoid the water from passing through. You will find if water, or dirt either one, pass into the tank, it is going to cause trouble that the ordinary man cannot locate, and yet it is a very easy matter to locate it if you understand the principle of the carburetor. For instance, I shall explain to you the Schebler carburetor. The Schebler carburetor is a foreign type that has a water jacket. The type that I am showing you here is type F in which the adjustment is very easily made.

The first thing is to understand the color of blazes that you will receive from rich, weak and proper mixtures. If your mixture is too rich, you will receive a red smoky blaze; if the mixture is too weak, you will receive a yellowish green blaze. When the mixture is just right, you receive a deep blue blaze. This blaze can be seen from the muffler, when it is cut down and will show up at high speed. Also, it can be seen by opening the valve at the head of the cylinder, or priming cups.

The sound which you receive from too rich a mixture is a buzzing sound, which means that the motor runs sluggishly. The weak mixture gives a low, hollow-tone sound. The right kind of a mixture gives a deep, sharp report like two pieces of boards slapped together.

The trouble of the carburetor may be found in several different places. If dirt passes in the pipe line and chokes up, the trouble that you will have is that your motor will choke down, backfiring through the carburetor, causing the car to stop. When you get out and crank up your car, even though it starts off again at a very high speed like nothing was wrong, it will run only a few minutes until the same thing takes place—backfiring through the carburetor and the stopping of the motor. This shows that the dirt has clogged in the pipe line and the gasoline does not feed through as fast as it ought to, or stops up in the elbow G. This condition allows the gasoline to seep through when the car is stopped and to fill the float chamber full again. Then when you crank your car it starts off because it has a supply of gasoline in the float chamber. After you have removed the pipe line with your pump, you can remove the dirt or blow it out. If you have no pump, get a piece of wire that you can run through and by tying a small swab to it you can pull this through and thus clean the pipe line out.

If this dirt should happen to pass on through under the needle valve H it would allow the inside valve to be held open, and this would cause the carburetor to flood. The gasoline then keeps running in since the inside valve cannot shut it off when it gets to the height that it should be at the point D. This running above causes it to run through the spray nozzle and out on the ground, and this is what is called flooding. You may ask, "Is there any other cause of flooding?" There is. You will find that if your cork float becomes soaked with gasoline it becomes heavy and lays down in the gas, allowing the gas to raise higher than it really should, causing the gasoline to run out in the same way. Again you will ask, "Is there any way of fixing this?" There is. If the dirt gets under the inside valve, you can fix it by removing the dirt, and, if the cork float gets soaked by gasoline, by drying it out thoroughly and then taking it and dipping it in some shellac. This should be done three times, letting it dry about fifteen minutes each time. This will prevent the gasoline from soaking into the cork float.

Should the dirt pass on into the float chamber and up into the spray nozzle D, it would cause the gasoline to be shut off entirely from passing on up through the manifold. This trouble can be located only in this way: Take gasoline from the top of your tank, prime the cylinders, and you will find that when cranking your motor the gasoline will ignite, making three or four explosions and then stopping. This proves to you that you spark is all right and that the trouble is in the carburetor system. Now, by going to work and flooding the carburetor by pushing down on the stem V, you will force the cork float down, allowing gasoline to pass in through by J and allowing it to run up above the spray nozzle. If there is no dirt in this spray nozzle it should allow the gasoline to run out through your air hole on to the ground. If it does, you will know then that there must be water in the gasoline. If it does not, it goes to show you that the spray nozzle is stopped up and will not allow the gasoline to pass through.

By taking the nut off the bottom you may be able to take the float chamber apart. This will allow you to run a piece of wire up through the spray nozzle, removing the dirt which has gathered there.

If you have any doubt about water being in your float chamber, go to work and prime the cylinders with gasoline from the bottom of your carburetor. If the car will not start with this, it proves to you that it is water in the gasoline.

The foregoing, you will find, is the most of the trouble that you have with the carburetor. However, in addition, you will find that you will have such trouble as the adjustment not being proper; or the manifold may leak from the vibration of your car, breaking the packing between the manifold and the cylinders, allowing air to pass in through the place where the packing is broken.

You will find that this carburetor has a low and high speed adjustment, which high speed adjustment is found on the throttle V. The low speed adjustment is the needle valve L and the air valve A, which adjustment is made at M.

A very good way to adjust this carburetor that has proved satisfactory to me is to get a very light tension on your air valve spring M, by the adjustment screw, and then open the needle valve L about one turn. Then start your motor, having the throttle closed. Next close the needle valve L until your motor starts to miss. Just as it starts

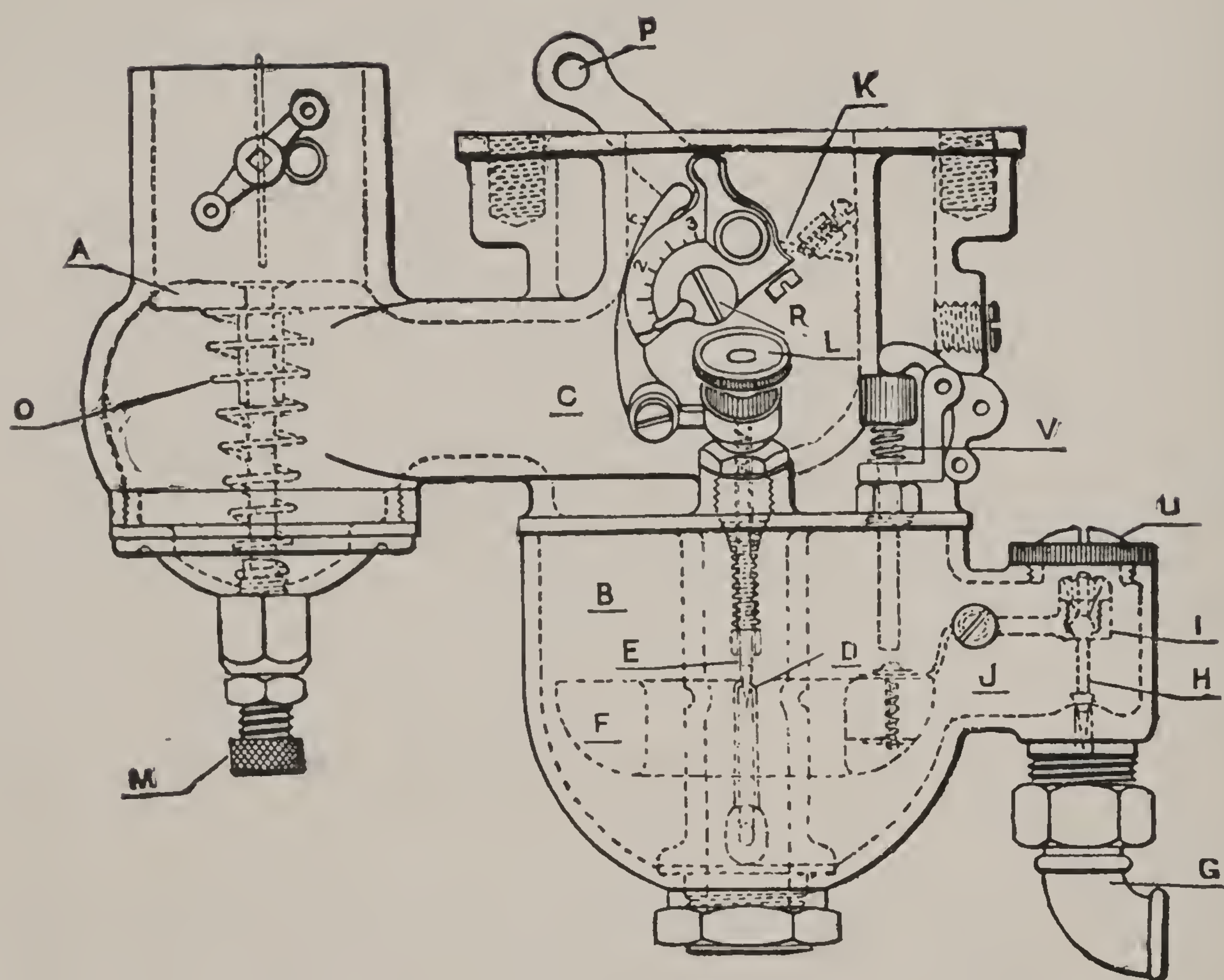


FIG. 162.—The Schebler Carburetter. A compensating air valve A, adjustable by the screw M and spring O, controls the air supply to the mixing chamber C. Above this valve is a shutter which may be partially closed when cranking to increase the suction in order to obtain a rich mixture. The spray nozzle is located at D and the supply regulated by the needle valve E by means of thumb wheel L. The needle valve has two adjustments, one for high speed and one for low. At R is the eccentric high speed adjustment. Throttle valve K is of the butterfly type and is operated by the lever P. Heating is secured by a jacket surrounding the throttle. Gasoline enters the float chamber B through the elbow connection G. The fuel level is maintained by the concentric float F which regulates the supply by the inlet valve H and lever connection J. The float point is adjustable by the needle valve adjusting screw I, accessible by removing cap U. The carburetter is primed by the tickler or flushing pin V.

to miss, open the needle valve again until you get a regular explosion on all four cylinders. After receiving a regular explosion, adjust the air valve A with the adjustment screw M until your motor runs in perfect tune. Then open the throttle P wide open and make the adjustment by the adjustment screw V with a screw driver, until your motor runs in perfect tune at high speed. You will find this can be done by turning the screw one way or the other when it raises the needle valve or lowers it. As the throttle is being pulled open, the needle valve opens, allowing more gasoline to pass in through the spray nozzle. This will allow you to take more gas as you will be taking more air, as the high speed of the motor will draw the air valve open to a greater extent, allowing more air to pass through. It is then necessary to have more gas to make the mixture proper.

The ignition system must be in first class shape when undertaking to adjust the carburetor. The above way of adjusting this carburetor has proved very satisfactory. When you have once become acquainted with the adjustment, you will find it is much easier to make the same as you can then locate your sound and tell whether the sound of the motor is coming right. At first you may not be able to make the adjustment just as you would like to, but practice will make perfect.

TYPE L

You will find that the type L is practically the same carburetor except it doesn't have a water jacket and the adjustment is made by the air valve and the needle valve. This carburetor is used on a great many small motors, since it gives special satisfaction on such motors.

The troubles in it are found the same way as in the one I have just mentioned, since they are both made by the same factory. The adjustment of the type L is a little bit different from this one. The way I generally adjust the type L carburetor is by opening the needle valve, for a 20-horse motor about three-quarters of a turn; for a 30-horse about one turn and a 40-horse about one and a quarter turn. Then, having a light tension on my air spring, I will start the motor. While the motor is running, I will adjust the needle valve until it begins to hit regular at low speed. Next I open the motor wide and adjust the air valve until the motor begins to draw hard through the air valve. Then I give it gas until you get the proper sound, which resembles two pieces of boards clapped together.

Another way in which you can adjust this carburetor is by opening the needle valve about the same distance and adjusting the air valve for low speed, and then opening the throttle wide and adjust the needle valve until you get it as near as you can.

Still another way: you can open the needle valves the same distance and then start your motor, throwing the throttle open suddenly. If spitting takes place, through the air valve, close the air off until the spitting quits. Then open again until the spitting just takes place, and then open the needle valve little by little until you get the slightest pop and your motor will rush off at high speed. But be sure and open and close the throttle suddenly at each adjustment. This adjustment will only work on the type L Schebler, or such makes.

STROMBERG CARBURETOR

Figure No. 50 shows you a Stromberg carburetor, which is a spring type having a water jacket and air valve adjustment. This carburetor has a spray nozzle, but does not have a needle valve in which the adjustment is made at the spray nozzle. It has a needle valve at the float chamber in which the adjustment of the gasoline is made in the heighth of the glass float chamber C, this adjustment generally being made so that the gasoline stands about one-half in the float chamber while the motor is running. This adjustment is made by the adjustment screw D1.

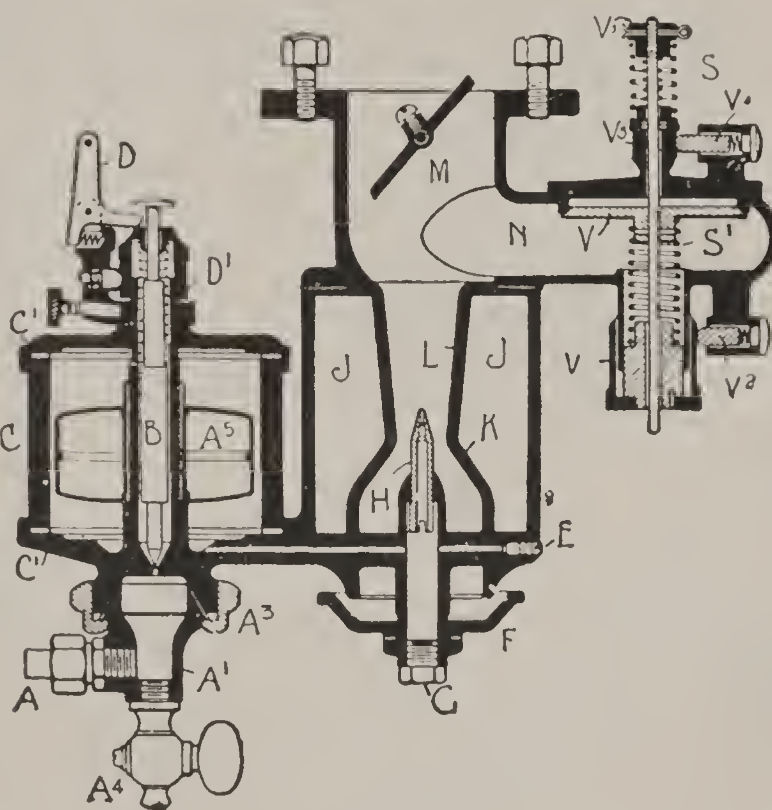


Fig. 50
STROMBERG CARBURETOR

You will notice that the gas feeds in at the pipe connection A and passes up through the needle valve B at the bottom. Here it passes into the float chamber, raising the float A5. The gas then passes across through the spray nozzle H, where it then passes up through the throttle M and through the manifold to the cylinders. The air passes in at the bottom of the priming cup F, which is the factory set point, and the straight air passes in through the air valve V going in past N, mixing with the gas at M, and passing up through the manifold in a vapor of gas. The adjustment is made at the adjustment screw above V and the adjustment screw below V, the bottom one being the light spring adjustment; the top one being the heavy spring adjustment, or high speed.

The troubles of this system you will find about the same as the others. The dirt passing in the pipe line will cause it to choke down, which, if noticed at the glass, it will be found that the gasoline is low and seeping in. If this dirt passes in and gets under the needle valve B it will hold it open, allowing the gas to pass in. This gas will run across in the spray nozzle H and over the top into the cup F, and then it will run out on the ground. Sometimes this float chamber A5 becomes punctured, which can be easily fixed by soldering it lightly.

If the dirt which I have spoken of passes across into the spray nozzle H, it will choke the gasoline off entirely, not allowing it to pass up through the throttle M. In this case your motor would stop, and the only way that you could locate our trouble would be first to prime your cylinders to see if your motor will run or not; or, next by priming to see whether the trouble is in the gasoline system or the ignition system. Finding it will ignite the gas shows you that your spark is all right and the trouble is in the carburetor. By pulling back on the lever D, you will raise the needle valve B allowing the gas to run in and fill up to the top of your float chamber. Should it run out of the spray nozzle into the priming cup F this shows you that the gas is passing through and it must be water. After the gas reaches this point, there is nothing to keep it from passing to your cylinders. Should it not, you will find it is dirt in the spray nozzle and this will not allow the gas to pass through.

The dirt can be removed by taking off the screw at the bottom G and with a piece of wire you can remove the dirt, since you can easily see through the spray nozzle.

If this dirt should stop in the cross section from the float chamber to the spray nozzle, by removing the screw E you can push a piece of wire through the cross section, removing the dirt from this point.

If you wish to take this float chamber apart, remove screw C at the top, allow the floating lever to be removed at D and then the adjustment screw D will screw off, allowing you to pull out the needle valve B. Then throw off the top of the case, lift up your glass C and you have everything removed.

By removing screw G you can screw off the priming cup F, allowing you to look through your carburetor.

The letter J is the water jacket into which the hot water from your cylinders passes in and out again, keeping the gasoline hot while it passes up through the air space L.

In case you want to drain off the water that may be in the carburetor, you can do so by opening valve A No. 4 and pulling back on the lever D. Then raise the needle valve B, allowing the gas or water, whichever it may be in the float chamber, to pass down through the valve below.

If you want to adjust this carburetor, you can do so by adjusting the gasoline so it stands about one-half in the float chamber. This can be done by the adjustment screw D. Then have a light tension on both springs. Start the motor and while the motor is running adjust the gasoline by the adjustment screw above D, so that the gas will still stand half in the float chamber while the motor is running. This allows the gas to rise at the proper height in the spray nozzle. Then while the motor is running slowly, adjust the lower valve spring V or spring S, low speed adjustment, until the motor runs perfectly at low speed. Next open the throttle wide open. Leave your spark retarded and adjust the spring above, or heavy spring, until your motor runs perfectly at high speed. This is high speed adjustment.

You will find that this adjustment will work out satisfactorily, providing your ignition system is in good shape.

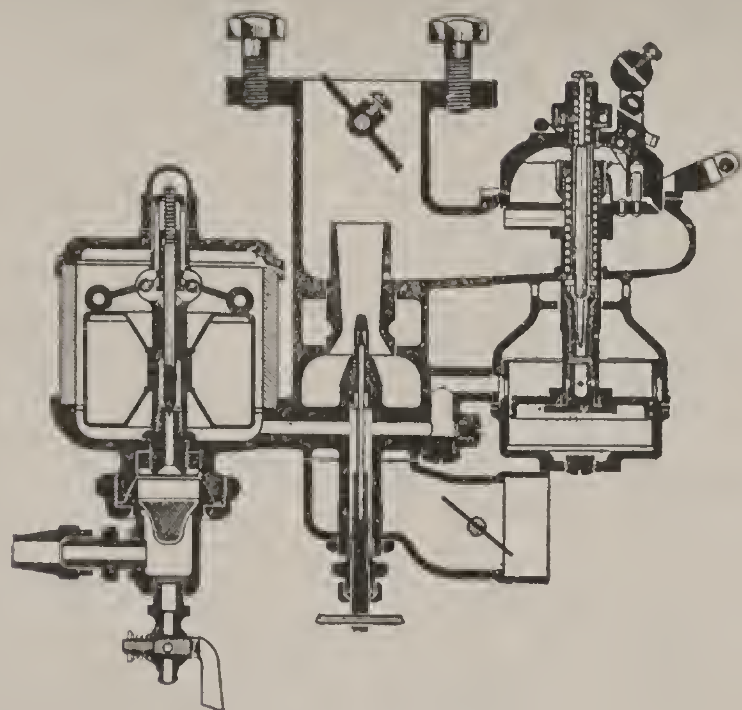
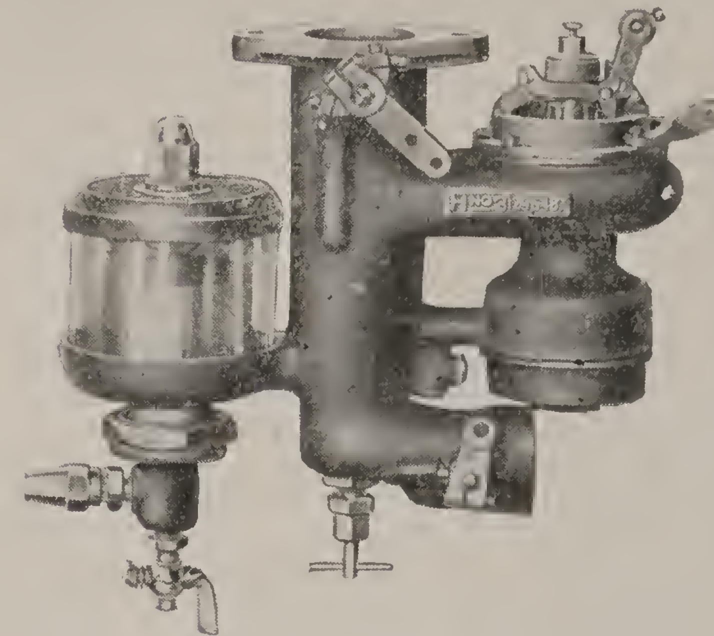


FIG. 42.



TYPE H STROMBERG CARBURETOR

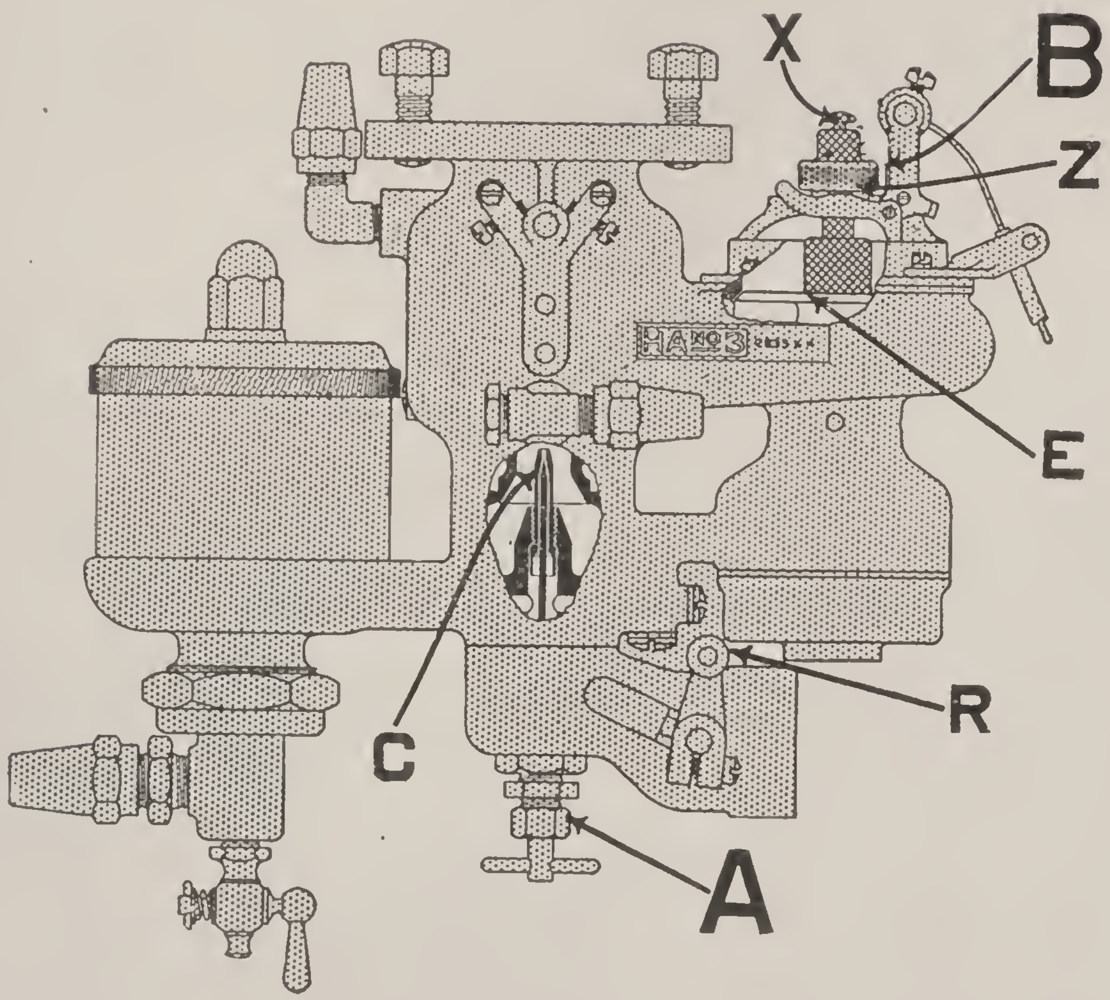
The type H. Stromberg carburetor is a carburetor that is very easy to adjust and will be found in the other illustrations explained as we use 42 to show an open cut of this type of carburetor, as it is just the same as H. A. No. 3.

Figure 43 showing a plain view of the H. No. 3 Stromberg carburetor.

Type "H" and "HA" carburetors are identical in construction, except that the "HA" is built with a water jacket, while the "H" is not.

GASOLINE ADJUSTMENT

The float level adjustment on this carburetor is set and locked at the factory and never needs attention. Also the air valve spring adjustment is locked at the factory.



ADJUSTMENT

There are only two adjustments on this carburetor, "A" the low speed, which is a needle valve seating in an open nozzle, the opening of which is usually two sizes larger than is ordinarily necessary which permits an increase in the gasoline flow to that extent, and which also can be shut off entirely. The other is the high speed adjustment "B" which controls the flow of gasoline on high speed by regulating the time when the secondary needle valve begins to open.

Before starting the motor, open all pet cocks on the carburetor so that the inrush of gasoline will clean out any dirt which might have gotten in the carburetor in packing or otherwise, and set the high speed nut "B" so there is at least 1-32 of an inch clearance between it and the needle valve cap above it at "X" when the air valve "E" is on its seat. The needle valve does not begin to open until "B" comes in contact with "X."

Also before starting the motor, be sure the rocker arm of the dash adjustment on the carburetor is not in contact with the collar above it at "Z," when steering post control is all the way down.

STARTING THE MOTOR

To start the motor, raise the steering post control to its highest position, thus producing an extra rich mixture. In cold weather it also may be necessary to close the air supply in the hot air horn by means of a rod connected to "R." This should be opened as soon as motor starts. Gradually lower the steering post control as the motor warms up, and be sure same is in its lowest position and that the motor is thoroughly warm before adjusting the carburetor.

LOW SPEED ADJUSTMENT

The mixture at low speed is controlled by the needle valve "A." If too rich as indicated by the motor "rolling" or "loading," turn "A" up or anti-clockwise, thus admitting less gasoline and making the mixture leaner. If mixture is too lean, turn "A" down or clockwise, thus admitting more gasoline and making the mixture richer.

HIGH SPEED ADJUSTMENT

Advance the spark, open the throttle. If mixture is too lean on high speed, turn "B" up or anti-clockwise until desired results are obtained. If mixture is too rich, turn "B" down or clockwise.

NOZZLE SIZES

These carburetors are equipped with the proper size nozzles for the motor for which they are intended before leaving the factory, and no change should be made until positive that the proper adjustment cannot be obtained without making the change. Before changing nozzles, check up closely on the ignition system, examine all manifold and valve head connections, for air leaks, as it is absolutely impossible to make a carburetor operate properly if the ignition is not in good condition or there are air leaks in the motor.

If, however, with the motor in normal condition it is necessary to turn needle valve "A" down more than two and a half turns, and still motor will not idle, it indicates that the primary nozzle is too small and that a larger one should be used.

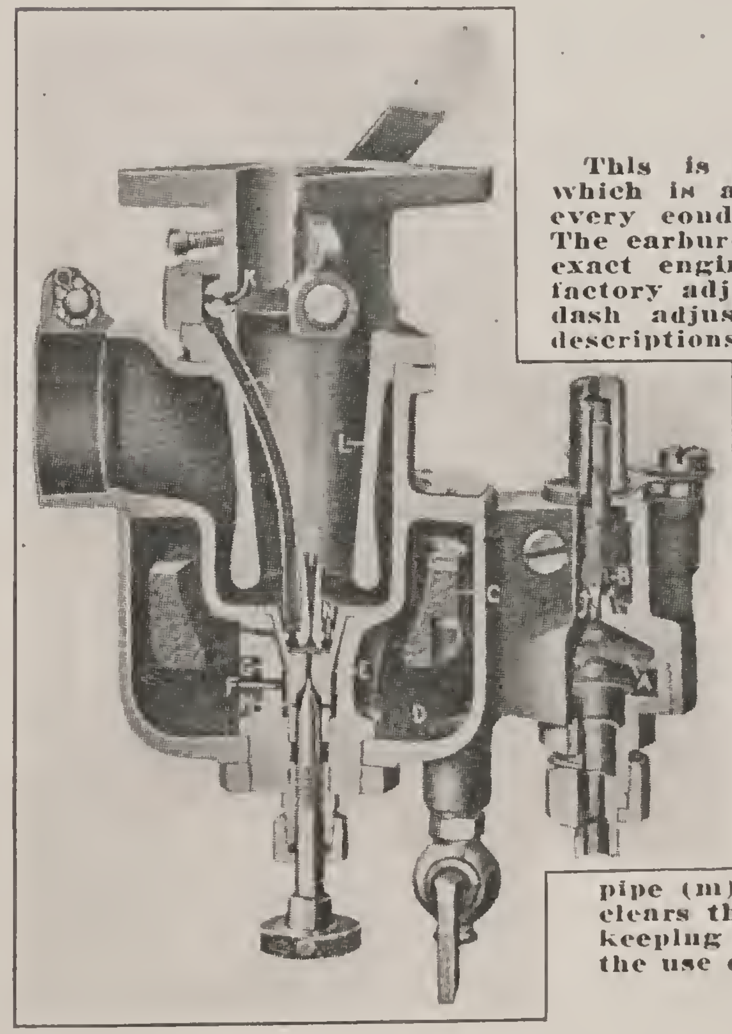
If it is impossible to get enough gas on high speed except when nut "B" is so high that there is no clearance at "X" on idle, a higher number needle should be used. If too much gas on high speed when nut "B" is turned down as far as it will go, a lower number needle should be used.

To change the primary nozzle, take out the needle valve "A" and remove nozzle "C" with a regular screw-driver. To remove taper valve on high speed, pull up steering post control, unscrew nut "B" all the way and lift valve out. This valve and nut "B" are assembled together and should be ordered in that way. Do not attempt to take these apart or to change the taper.

Never change nozzles more than one size at a time. The nozzle opening gets smaller as the number gets larger; thus—a No. 59 is smaller than a No. 58.

High speed needle valves deliver more gas as the number gets larger thus—a number 7 will give more gas than number 6.

Always install carburetor with the float chamber towards the radiator.



This is the famous Holley Carburetor which is adjusted from the dash to meet every condition of temperature and speed. The carburetor is set at the factory for the exact engine on which it is used and its factory adjustment cannot work loose. The dash adjustment is very simple and full descriptions accompany the car.

Gasoline to work properly in a motor must be vaporized perfectly with entering air. The dash adjustment accomplishes this result by supplying all cold air for the hottest temperature and all hot air for the coldest temperature and by furnishing the supply of hot and cold air for any intermediate degrees of temperature. In operation this carburetor depends on the relation of supplied gasoline from the spray nozzle (g) with the entrance of air downward through the bridge end and up to the stand pipe (m). As the speed of the motor increases more air and less fuel is delivered through the stand pipe (m) to the motor. This automatically clears the mixture as the speed increases, keeping the proportion constant without the use of a single moving part.

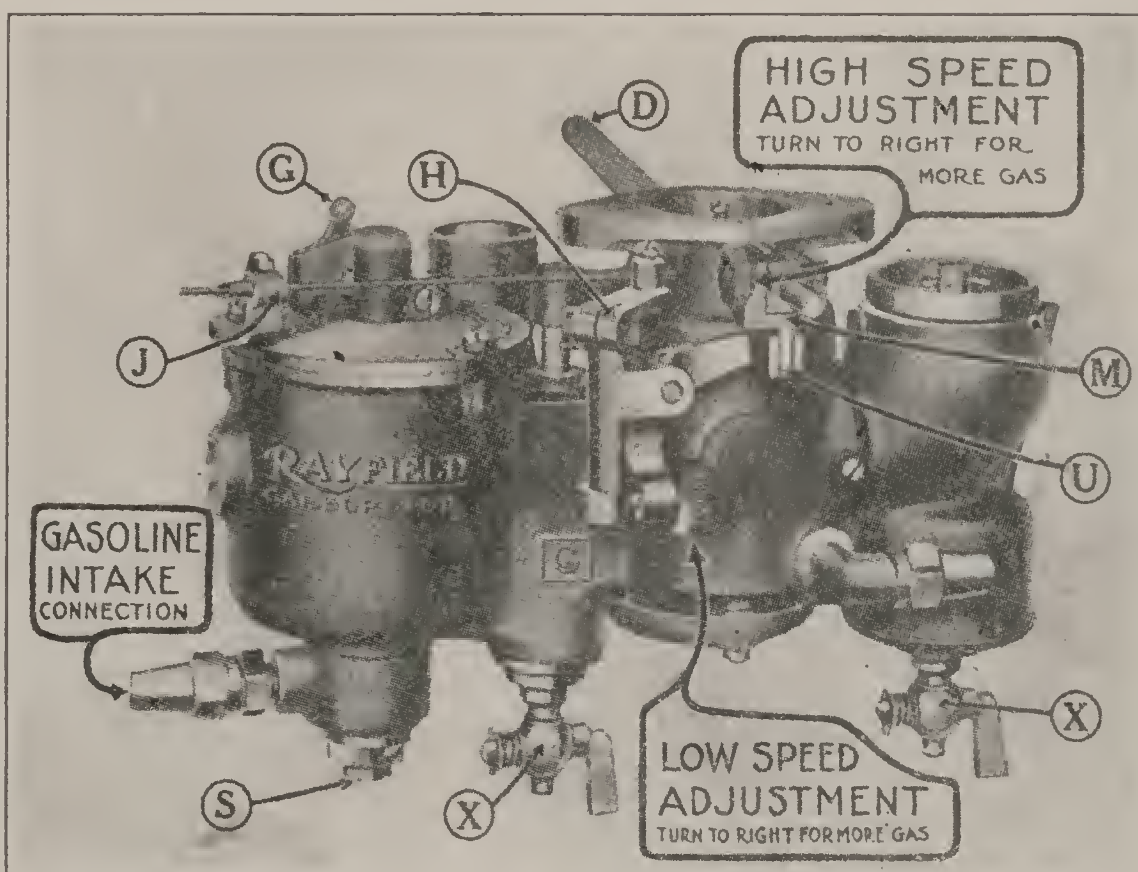
MODEL G (WATER JACKETED)

Installation Instructions

These installation instructions also apply to Model L except as to water connections.

The Rayfield Carburetor will operate successfully on all motors, but best results can only be obtained by correct installation. These instructions should be followed closely.

Position—Place carburetor as close to cylinder intake ports as possible, with float chamber facing either front or rear and with adjustments on the outside. Where gravity feed is used, carburetor must be placed low enough to insure flow on hills when gasoline is low in the tank. The throttle lever D can be used on either side of the carburetor. Priming cap can be turned to any position desired by loosening retaining screw.



CONNECTIONS

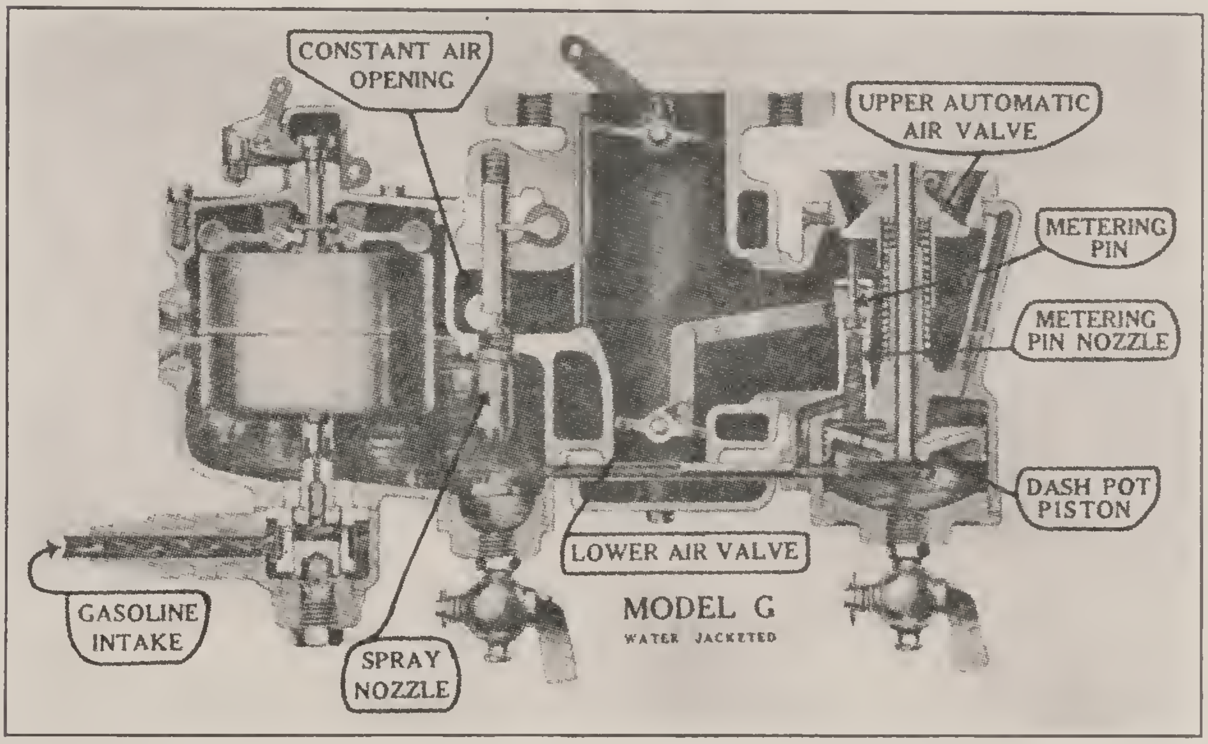
The opening in the manifold should not be smaller than the carburetor opening. If smaller, the edge should be beveled to size of carburetor, to avoid an abrupt shoulder.

The flange connection must be absolutely air tight. Use a good gasket.

The **Rayfield** carburetor is furnished with gasoline and water connections to take 5-16 outside diameter tubing.

Throttle connections should be made so that carburetor is fully opened by operation of the foot accelerator or hand throttle. A spring control should be arranged to positively close carburetor throttle when foot accelerator is released.

Use a copper tube with not less than one-quarter inch hole for gasoline connection. Under no circumstances use rubber tubing or iron pipe.



Connect a wire to the priming lever G for starting purposes.

Gasoline connection is adjustable and can be set at any angle desired, by loosening nut at bottom of trap.

Always connect hot water and hot air.

Connect water pipe from water jacket of motor or upper water pipe, to the top water connection of carburetor and from lower water connection of carburetor, to suction end of pump (between radiator and pump).

Place shut-off cock in the water line for use in extremely hot weather.

See that these connections are made in such a way that water will be drained out of carburetor jacket when system is drained.

Attach a hot air stove to the exhaust pipe and connect to constant air elbow of carburetor by a flexible tube.

DASH CONTROL

An important feature of the **Rayfield** carburetor is the dash control, which assures easy starting, regardless of weather conditions and permits control of the mixture from the dash. Raising the dash control lifts the spray nozzle needle and supplies a richer mixture.

Dash Control Installation—Locate position desired for the push button on the dash. Drill a 5/8 inch hole at the proper angle, attach the push button and run the tubing to the bracket J on the carburetor. avoiding sharp bends.

Cut off tubing so that it will extend beyond the bracket not more than one-quarter inch. Remove the temporary wire from the carburetor, insert tubing and secure permanently by tightening clamp screw. Run dash adjustment wire through hole in binding post on gash arm H.

With push button down, place gas arm H in position so that the line on eccentric comes in contact with low speed screw. Tighten screw in binding post. Cut off surplus wire. Without changing position of push button make carburetor adjustment.

GENERAL INFORMATION

Fuel conditions at the present time require the application of heat to the carburetor. Both hot water and hot air are strongly recommended, but one or the other must be used. In the case of Thermo-Syphon or air cooled motors, hot air should be used.

The water jacketed carburetor is always more efficient than the non-water jacketed carburetor.

MODELS G AND L

Adjustment Instructions.

Models G and L have no air valve adjustment and only two gasoline adjustments.

Important—When adjusting a **Rayfield Carburetor,** bear in mind that **both adjustments are turned to the right for a richer mixture** as indicated on adjustment screw heads.

Caution—Before adjusting the carburetor, be sure there are no obstructions in the gasoline line; that manifold connections are absolutely tight and free from air leaks; that valves and ignition are properly timed, and that there is a hot spark and good compression in all cylinders.

Always adjust carburetor with dash control down. Low speed adjustment must be completed before adjusting "high."

ADJUSTING LOW SPEED

With throttle closed, and dash control down; close nozzle needle by turning **low speed** adjustment to the **left** until Block **U** (see cut slightly leaves contact with the cam **M.** Then turn to the **right** about three complete turns. Open throttle not more than one-quarter. Prime carburetor by pulling steadily a few seconds on Priming Lever **G.** Start motor and allow it to run until warmed up. Then with retarded spark, close throttle until motor runs slowly without stopping. Now, with motor thoroughly warm, make final low speed adjustment by turning low speed screw to **left** until motor slows down and then turn to the **right** a notch at a time until motor idles smoothly.

If motor does not throttle low enough, turn Stop Arm Screw to the **left** until it runs at the lowest number of revolutions desired.

ADJUSTING HIGH SPEED

Advance spark about one-quarter. Open throttle rather quickly. Should motor back-fire it indicates a lean mixture. Correct this by turning the **high** speed adjusting screw to the **right** about one notch at a time, until the throttle can be opened quickly without back-firing.

If "loading" (choking) is experienced when running under heavy load with throttle wide open, it indicates too rich a mixture. This can be overcome by turning **high speed** adjustment to the **left.**

Adjustments made for high speed will in no way affect low speed. Low speed adjustment **must not** be used to get a correct mixture at **high speed.** The adjustment of the Rayfield cannot change. Both adjustments are positively locked.

Starting—Before starting motor when **cold,** observe the following:

Open throttle not more than one-quarter. Enrich the mixture by pulling up dash control. Prime carburetor by pulling on priming lever **G** for a few seconds.

When stopping motor, pull up dash control. Open throttle about one-quarter and switch off ignition. This leaves a rich mixture in the motor, which insures easy starting.

DASH CONTROL

The Rayfield Dash Control, when properly used, will render easy starting; furnish a richer mixture when motor is cold, and maintain a correct mixture under the most extreme atmospheric changes.

When carburetor adjustments are once made, they should not be changed, as the dash control will take care of cold weather as well as cold motor conditions.

Raising dash control enriches the mixture by lifting the nozzle needle. Control button should be **down** for running, except when a richer mixture is required.

Pull button up full distance for starting.

Adjustment of carburetor should always be made with dash control down and motor warm.

GENERAL INFORMATION

Never under any circumstances change nozzles in the model G. & L. Carburetors. The float level is correctly set at the factory. **Do not change it.**

A pressure of not more than two pounds is recommended where pressure system is used.

The automatic air valve should always be closed when motor is not running or when throttled down to its lowest speed.

Remember that the **low speed** adjustment is to be used **only** when motor is running idle and positively must not be used in adjusting high speed.

Never adjust a carburetor unless the motor is hot and the water jacket of carburetor warm.

The Float Chamber and dash pot should be drained occasionally through drain cocks X to remove water and sediment which may have accumulated.

All Rayfield Carburetors are equipped with a strainer trap at bottom of float chamber.

To clean trap, shut off gasoline supply and remove nut **S**. The gauze may then easily be removed and cleaned.

In replacing the trap, be sure that the gaskets are in place and nut is drawn up firmly to insure a tight joint.

The trap can be drained by shutting off the gasoline supply and removing small plug.

INSTRUCTIONS FOR INSTALLING AND OPERATING THE STEWART VACUUM GASOLINE SYSTEM.

Leave tank alone. Don't fool with it.

There is no reason why it should ever be opened, but in case of an accident, the following directions should be carefully observed. The tank positively must be placed so that its top is ABOVE the gasoline supply tank. Under no circumstance can the storage tank be as high as the vacuum tank.

The Stewart Vacuum Gasoline Tank is installed on the engine side of the dash. The bottom of the tank should never be less than 3 inches above carburetor, and, in any event, the tank should be placed **as high as possible so as to be always above the main gasoline supply tank even when car is going down steep grades.**

It is connected (at D) with the main gasoline supply tank; also (at C) with the intake manifold (at K) with the carburetor.

The top or head of the Stewart Vacuum Gasoline Tank is held in place by eight screws. Between this and the tank is a gasket. This gasket is shellaced. If for any purpose you have to remove this head, use care to prevent damaging this gasket, as it is necessary that this should be an absolutely air-tight joint.

A is the suction valve for opening and closing the connection to manifold and through which a vacuum is extended from the engine manifold to gasoline tank.

B is the atmospheric valve, and permits or prevents an atmospheric condition in the upper chamber.

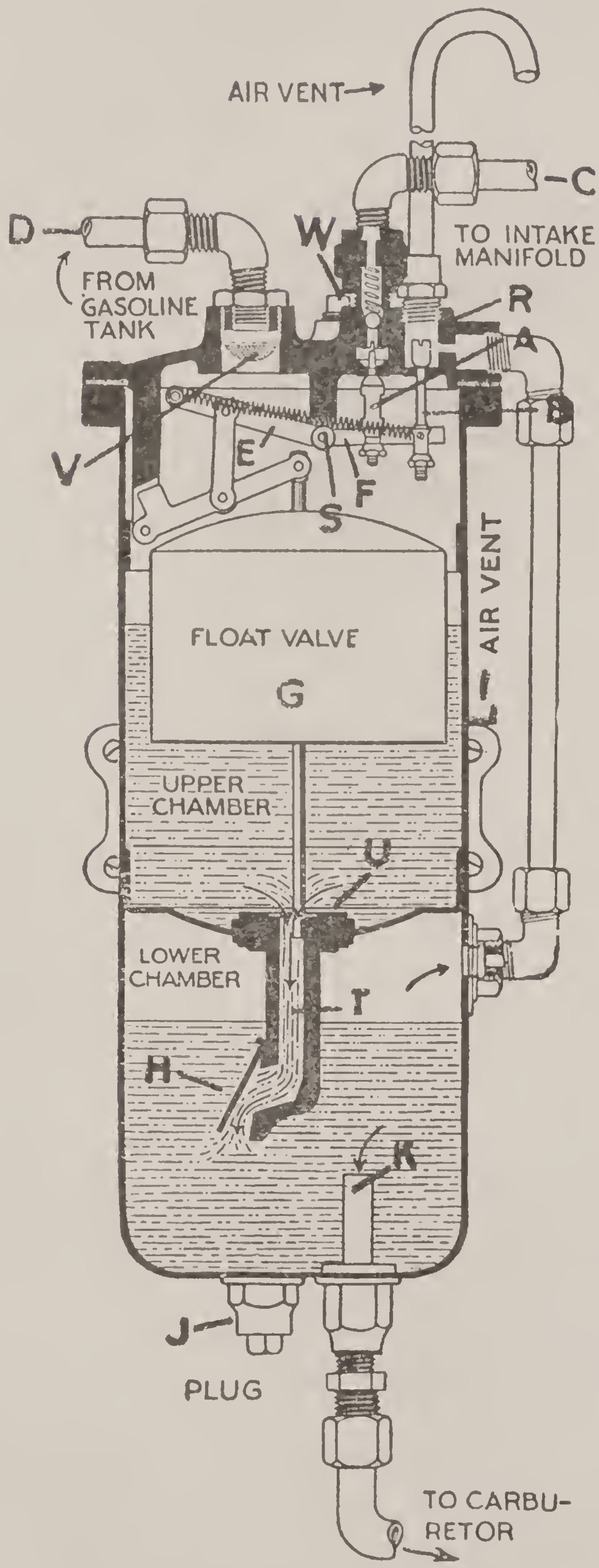
C is pipe connecting tank to manifold of engine.

D is pipe connecting vacuum tank to main gasoline supply tank or reservoir.

E is lever to which the two coil springs S are attached. This lever is operated by the movement of the float G.

F is short lever, which is operated by the lever E, and which in turn operates the valves A and B.

H is flapper valve in the outlet T. This flapper valve is held



VACUUM GASOLINE SYSTEM.

closed by the action of the suction whenever the valve A is open, but it opens when the float valve has closed the vacuum valve A and opened the atmospheric valve B.

J is drain plug for drawing water or sediment out of reservoir. This may also be used for drawing off gasoline for priming or cleaning purposes.

K is line to carburetor extended on inside of tank to form pocket for trapping water and sediment, and which may be drawn out through plug J.

L is vent pipe, admitting an atmospheric condition in lower chamber at all times, and permitting an even, uninterrupted flow of gasoline to carburetor.

R is an extension pipe over the atmospheric valve. The purpose of this extension is the same in effect as if the tank itself was raised, and prevents any overflowing of gasoline in case the front end of the car should be very much lower than the rear end.

If the tank should have a tendency to continue to fill to a point that causes the suction line to draw gasoline into the manifold, it may be due to a leaky float. This is easily found out by removing the top of the tank, and shaking the float to see if any gasoline has leaked into it, in which case the gasoline would give it extra weight and prevent it from rising so as to operate the valve.

T is the outlet in which is the flapper valve H, and located at the bottom of the float reservoir. It can be unscrewed with a screw driver (see slot U), and removed if desired. Sometimes the flapper valve becomes pitted with carbon or some other sediment, which prevents it from seating properly. In such a case scrape this flapper valve with a knife so that it will seat flush against the face of the outlet.

To fill the tank, should it ever become entirely empty, close the engine throttle and allow the engine to turn over with the self-starter a few revolutions. This will create sufficient vacuum in the tank to fill it. If the tank has been allowed to stand empty for a considerable time and it does not easily fill when the engine is turned over with the starter, this may be caused by dirt or sediment being under the flapper valve H. Removing the plug W in the top and pouring a small quantity of gasoline into the tank will wash the dirt from this valve and cause it to work immediately. If the motor speeds up when the vacuum tank is drawing gasoline from the main supply it shows that either your carburetor mixture is too rich, or, your connections are so loose that it is drawing air into the manifold. There should be no perceptible change of engine speed when the tank is operating.

TRANSMISSION

The next mechanical part that we take up is the transmission. You will find that there are a very few that understand how to change speeds on a car, and the reason that they do not is because they do not understand the principle of the transmission. A great many people changing speeds cause the machine to make a ripping, roaring noise. This can be overcome in shifting, if you understand how it is done. The majority of instructors who teach you how to drive a car teach you wrong in this matter. You will admit that you have been in the habit of releasing your clutch clear out when changing speeds, and this should not be done by any means. If you understand the principle of a transmission, you will plainly see why this noise is caused.

When you buy your car, the first thing you are taught is to be sure and push down on the pedal, which is called the release. You are told to do this, but you don't understand why. You will find that you do so because you were told to do so, and told that if you didn't do it you would rip out your gears, which is true. And yet, if you push down on the pedal you will chew off all the teeth, and that will be just as bad as to rip them out.

Now, these instructions conflict. You think that you ought to release them out, and I say not to. I do not mean not to release the clutch; but I do mean that you should release the clutch far enough to release the motor power from the transmission, since this is what the clutch is made for.

You will find that a transmission has a jack shaft and a drive shaft. The figure No. 34 will show you a selective type transmission, which you will notice on one shaft has four gears. This is the jack shaft. On the other shaft you will notice that there are three gears, which is the drive shaft. But really, there are only two gears on the drive shaft, as the gear which is running enmesh with the other gears is a stub gear inside of which the drive shaft rides. This gear is driven by the clutch which you release and leave in.

You can look at this yourself and see that if you release this clutch clear out you will stop the clutch from running. That is all right in starting up; do that when first starting your car from the standing position. If you stop the clutch and stop this stub gear that is running enmesh with the gear on the jack shaft, you will stop the jack shaft from running. As your car is standing still, the other two gears which are slide gears will slide backward and forward on that square shaft. As the gear then is standing still and the gears on the jack shaft are standing still, you can see at once that the gear can be thrown either way enmesh with one of the gears and not make a particle of noise. Say that you get first speed. You throw the large gear on the drive shaft forward enmesh with the gear that is in the center. This gives you first speed. Now, in order to go from first to second speed you must shift out and throw the near gear on the drive shaft back into mesh with the center gear and this will give you second speed. To illustrate the point we will say your car is running when getting first speed. Your drive shaft then would be turning, and also the gears on the drive shaft are bound to be turning also. If your car is coasting while changing speeds, the momentum will keep the two gears on the drive shaft running. Now, if you release the clutch clear out, you can see that you will stop the jack shaft from running. As you do so, you are going to slide this second, or intermediate speed gear back into mesh with a gear that is standing still, while your sliding gear is running from the momentum of the vehicle. This shows you conclusively that the gear that is running is going to rip and roar as it passes by the teeth on the gear in the center of your jack shaft.

Since this is true, why should you release the clutch clear out? You should only release the clutch just far enough to release the motor power from the transmission, still allowing the clutch to run from its momentum. If you will allow the jack shaft to run, and the drive shaft also, both gears as they are running towards each other will slide together without making a particle of noise.

When changing from intermediate or second speed to high, the same gear is slid ahead where the two lugs are working together, giving you a direct drive. Then the small gear which is running enmesh with the large gear at this time is connected to your sliding gear, making this one shaft straight through, and this gives you a direct drive from the fly wheel straight back to your differential.

I shall now explain to you how to start the car. First see that the spark is retarded. Then notice that your levers are in neutral, for if they are in a speed and you undertake to start the car, it is liable to run over you. Next start your car and take your seat, Shift your clutch out as far as possible until the clutch has stopped running, while all gears are standing still slide them, shifting the gear into first speed. Leave the clutch in easily. When the car starts to moving, after you have a fair speed on low, release the clutch just enough to release the motor power from the transmission and change speeds quickly from first to second. You will find that this can be done without making a particle of noise.

To change from second to high, release the clutch again just far enough to release the motor power from the transmission, shifting as quickly as possible into high speed, leaving the clutch back in easy again. Now you are on direct drive and high speed.

To get reverse, you will notice at the back of the transmission that the largest gear on the drive shaft can be slid into an idle gear which is enmesh now with the jack shaft. This gives you the third motion, which will run this gear on the drive shaft to the reverse. This will cause the car to back up.

You may ask, "If all these gears were to drop out, could I get home?" You most certainly could. The sliding gear next to the gear which is enmesh from the drive shaft to the jack shaft can be slid ahead and this connects the two lugs together. This connection makes the direct drive. When this is made you will not use any of the gears then whatever. All the teeth could be gone and the direct drive will operate your car. It is rather hard to start on high speed, but by driving your engine up to high speed and leaving the clutch in easily and allowing it to slip until the vehicle starts to moving, you can gradually raise your speed until you are driving on direct drive high speed. You should keep oil about even with the top of the shaft in

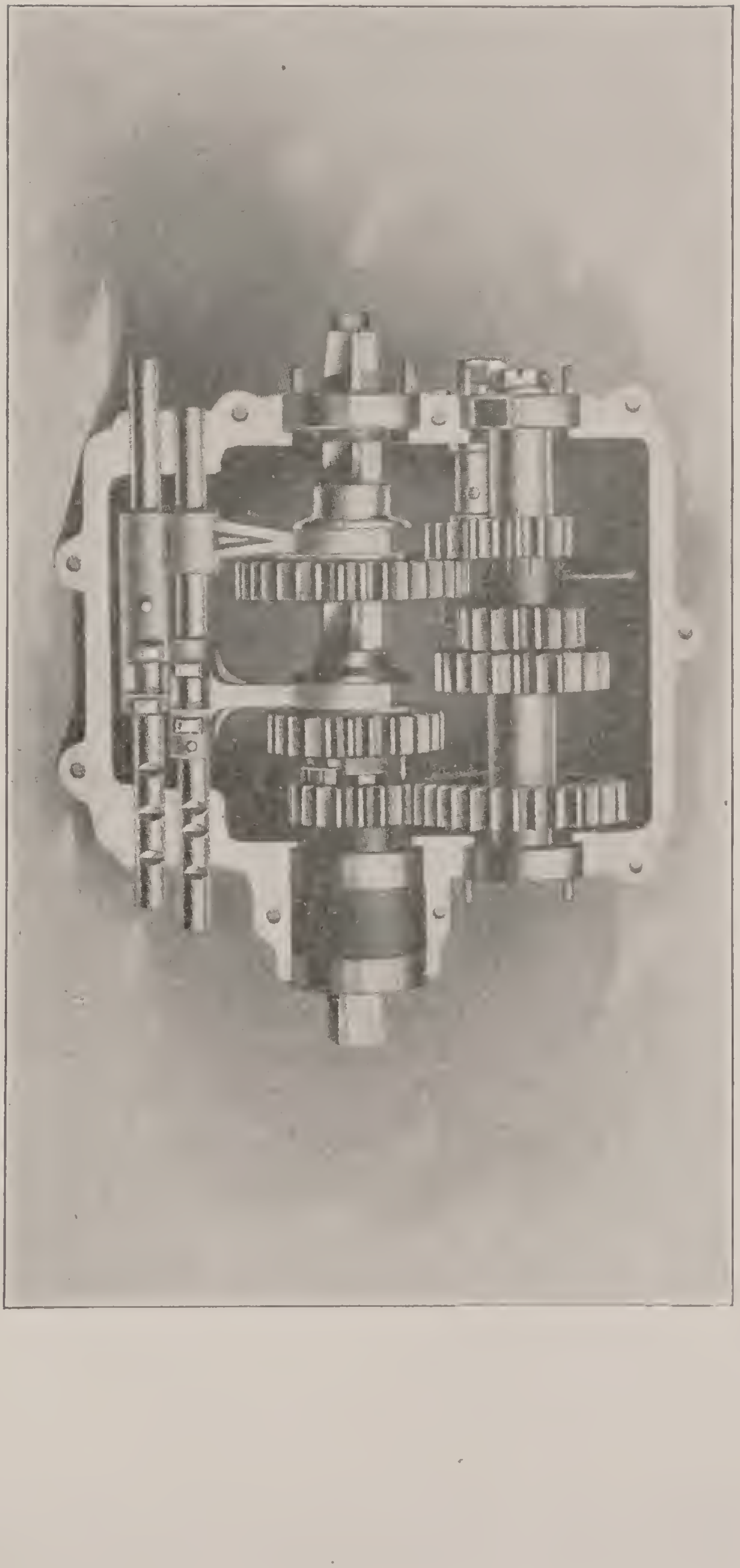


FIG. 34.
SELECTIVE TYPE TRANSMISSION

this transmission. You will find that these gears must be run in oil as they are very hard and will not stand to run dry.

A great many people who are driving selective type transmissions wonder whether or not they would be able to drive any make of a car and know how to change the speeds. That is so easily done that a blind man could do it. Did you ever notice on the slot of the shifting lever that there was one slot shorter than the others? This is always high speed, no matter where you find it and no matter on what corner, it is always high speed. Straight across from it is always first speed. Likewise, straight back from first speed is always reverse, and straight back from high the other slot is always intermediate or second speed.

You will say, "Well, I know some automobiles that have not got the slots in that way." This is true, but they can be found just the same. If you have an open slot, throw your lever across it and shove it down to each corner when the motor is standing still. You will find there is one corner which you cannot get the lever into, for two reasons: first, because high speed is one of the shortest shifting spaces there is, and another reason is that nine times out of ten the lugs will come against one another in place of slipping together and will not allow you to go down into the corner. This proves to you that that is high speed. Then across from it is first speed. Straight back from first speed is reverse. Straight back from the point that you cannot get into is second speed. These speeds can always be found in this way on any car with the selective type transmission. It will be but a short time until we will use nothing but the selective type, since it is coming to the front and being used on all of our late type cars. You will find that it has better gears, and you will find that these gears are made in such a way that they stand lots of abuse.

You may have wondered why a gear is so expensive. I shall try to explain to you why the gear is as expensive as it is. The process that a gear goes through makes the expense of it come high. The gear at first is made of soft metal that has been annealed by heating until red hot and buried in sand and allowed to cool very slowly. After it has cooled, it is placed in the lathe, is turned out and then milled until it is made in the shape of a gear. Then it is placed into a grinding machine where it is ground down to a thousandth part of an inch. If this gear now could be placed on the automobile and used, it would be much quicker made and much cheaper, but it has yet to go through a case-hardening and a pickling process. This is done by placing a large kettle of cyanide potassium on a fire and heating until it becomes a liquid. This is white in color when it is placed in the kettle and the workman must be careful not to inhale a particle of it, as it is deadly poison. While this is red hot, the gears are placed in it and cooked the length of time they desire to case-harden it. About ten minutes' cooking will case-harden to the extent of about the 64th of an inch. This liquid substance must go in only far enough to give it the wearing material and still leave the metal inside soft and tough, which gives it strength. If you were to case-harden a tooth clear through, it would be brittle and would break off. After this has been cooked to the length of time desired, it is then taken and put into a pickling process, which is nothing more than brine, water and salt, until it becomes a brine. The gear must be taken out with a pair of tongs which are case-hardened, and must be placed into the brine at once. It must be dropped as straight as possible, for if this gear strikes the least bit crossways, it will cause it to warp. Should the gear warp it is no account and will have to be thrown away. If it is warped even a little, it is placed back into the grinding machine and ground off until it will run quiet. A gear going through all these processes brings the expense of it high. In this way you understand why the gear stands the wear and is so hard. You will find that this would not do for hardening tools, as a tool must be tempered, which process you will find in another place in this book.

PROGRESSIVE TRANSMISSION

The next transmission which I shall explain to you is the progressive. Progressive transmission is so called because you have got to pass through other gears in order to get to the gear you want. This will be shown to you in Figure No. 35.

The progressive sliding gears are fastened together. When one turns they both turn.

This transmission is not being used as much as it used to be, although you will find it on a few of the old type cars even today. You will find this transmission works exactly to the same principle as far as shifting the gears by releasing the clutch is concerned. It is necessary that you release the clutch clear out in order to shift speeds properly. Shifting your speeds, the gear is shifted one way or the other so that it can pass through the other gears in order to get to the gear you want.

In the selective type you will find that this disadvantage is done away with by having the sliding gears separate so that you can slide into a gear and out again and do this without passing through gears. The way of shifting this is that you have but one lever, and this shifts from one end to the other.

On the Progressive you find high speed always at one end and reverse at the other. You will notice, generally to find these speeds you cannot shift your lever clear down into the corner on the end that you find high, as the gear will come up against the lugs and not allow it to go down. You will also find the notches on that end are close together, while on the reverse and first speed the notches are far apart, and you will always find first speed next to reverse. You will find that second speed may be found next to high and neutral may be found next to high. There is no way of telling this except by going to work and shorting your lever in the center notch and cranking the motor over before turning on the switch. If your car does not start, you know then that you are in neutral. By throwing it back towards reverse on notch you are in first speed. By passing ahead through neutral into the next notch next to high, you are in second speed. By going clear up to the end in which the short notch is found, you are in high speed. By going to the other end, you are in reverse.

First and reverse being found together, it only makes it necessary to throw back into reverse, back up, and throw ahead into first speed and go ahead. And then you have got to pass through first speed and through neutral to pass into second as shown here. Passing into second speed, you pass ahead, throwing the lugs together, and this gives you high speed. In order to do this, you have got to pass through all the gears on the jack shaft, and this is wearing and is more apt to cause trouble than when you pass in and out.

You will notice that the same trouble is caused here by ripping and roaring, and even more so than it is on the selective type.

If you will notice on transmission where the gears are ripped out, you will find that the intermediate gear is ripped out more than any other gear, this being done shifting from first to second. In shifting to first speed we always release the clutch clear out, and it can be done as it stops the jack shaft when the car is standing still, the gears not moving. But in shifting to second speed, the clutch is released clear out and this causes the jack shaft to stop while the drive shaft is running and the gears on the drive shaft rip the teeth off the intermediate gear. You will find by just releasing the motor power the same as on the other, this can be done without making this noise and without ruining your gear.

Sometimes it is impossible for a person to change speeds without making a ripping, roaring noise. I have also known it to be so that they couldn't get into speed. Every time they tried to shift into first speed, it would cause a ripping, roaring noise. This is caused from the clutch being too full. That is, the leather would not leave go or the clutch does not let go on the fly wheel and the jack shaft keeps running. If the jack shaft should keep running when your drive shaft is standing still, and you were trying to shift your gear enmesh, it would cause a ripping, roaring noise. They do get into mesh sometimes by jerking back right quick, and when this is done you will hear a ripping noise and then a snap when the two gears go together. This shouldn't be done. The proper way is to be sure that that is the trouble. If you release the clutch and hold it for about a minute and then try to shift into first speed and find that this ripping noise is still heard, you can make up your mind that your leather is too full. Or, if you have a multiple disc clutch, the trouble is that it is gummed and sticking. To remove this trouble take coal oil and pour it in the case, allowing the motor to run, washing the plates, and you will remove the gum from the plates and they will not stick on you. If the multiple disc clutch runs in oil, fill it up again with fresh, clean oil and you will do away with this trouble. If this should be a leather cone clutch, by getting your car out against an embankment or some other place where it cannot climb, and leaving your clutch in easy while the motor is running and leave it slip, not leaving it in so that it will take hold, you can wear the leather down in a short time so that it will release. Don't leave this in enough to burn the leather. When it gets too hot, stop your motor and let it cool. After it has been worn down, a good idea is to soak the leather with neatsfoot oil. This causes the leather to become soft and pliable again, which will keep it from grabbing. If your leather gets hard and gummy, when you go to lift the clutch in you will find that it grabs and the car will start suddenly, and the clutch should be washed with gasoline or coal oil and the leather should be soaked with neatsfoot oil.

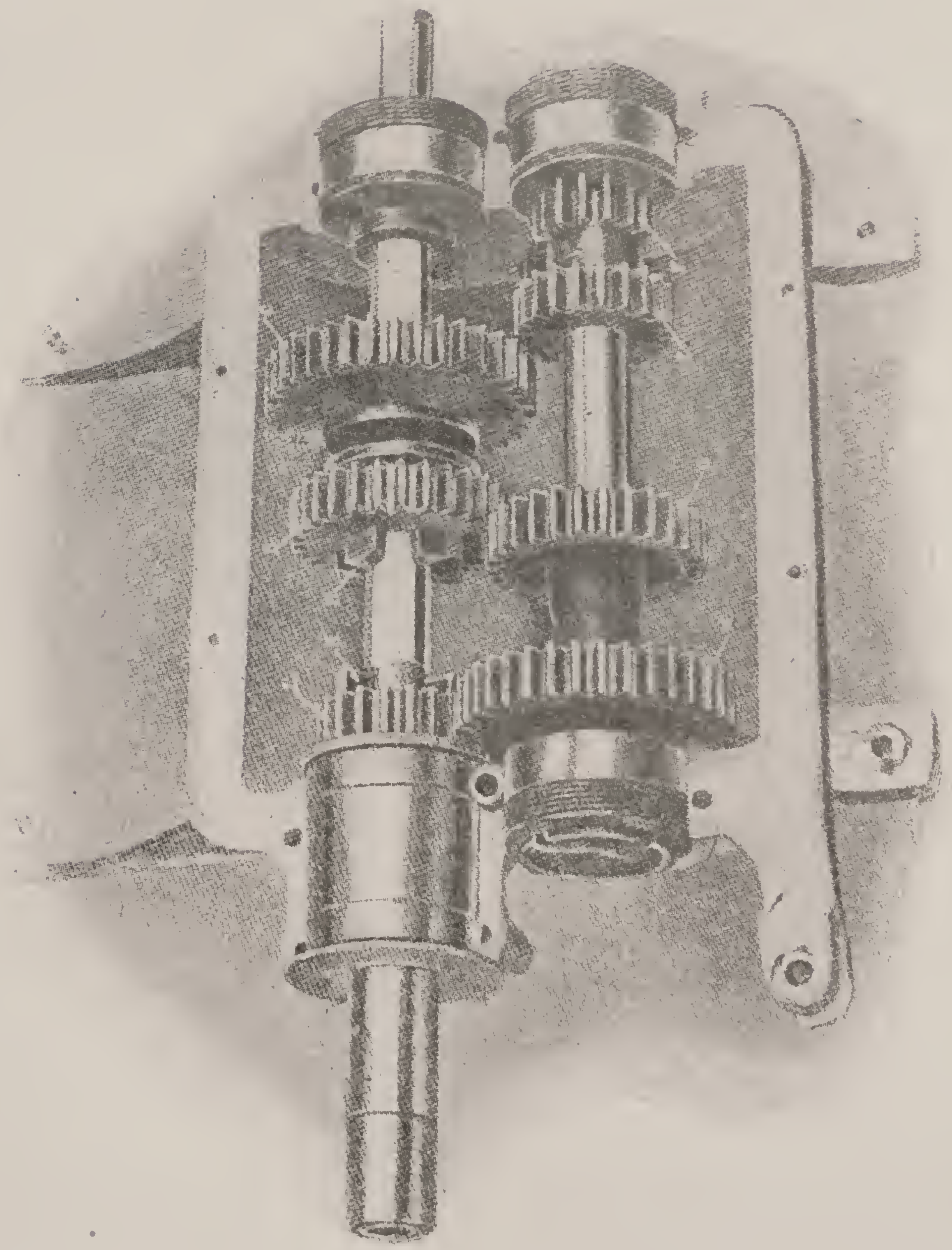


FIG. 35.
PROGRESSIVE TYPE TRANSMISSION

The same thing may be said about the multiple disc clutch when it becomes gummy. It needs cleaning out and fresh oil replaced instead of the dirty oil—that is, if the clutch runs in oil.

Sometimes a cone clutch gets in such shape that when you release it it keeps running and will not stop for about a minute. This is caused from the break or friction in which the clutch comes back again that stops it when releasing it clear out. It is worn out. If you raise your footboard you can see the clutch still running when you have got the clutch released clear out, and you can watch it die down from its momentum. If this be the case you have got to replace it, the trouble being most generally a small piece of leather in which the clutch comes back again. If it is not, it is a very good idea to have a strap or iron fastened onto the frame of the motor where it will run across to the front of the clutch, and rivet a piece of leather on it so that when the clutch is released clear out it will come back against this piece of leather, causing it to stop, for the clutch must stop in order to stop the jack shaft.

PLANETARY TRANSMISSION

The next system that I take up is the Planetary Transmission, about which you will have very little dealings, although it is used still today. Since this transmission is a very hard transmission to understand, you will find you will understand it better by dealing with it practically than you will from this illustration. In fact, it is hard enough to understand when it is taken to pieces and explained in such a way that a person has opportunity to demonstrate as well as to instruct concerning it.

It has a planet of gears, in which you will find there are 12 in this case.

The principle of this transmission, is that it has two cases, since you will notice that K is one of the cases in Figure 36, and H is the other case, having two sets of gears, E being one set of gears and F the other set. These gears lap half with each other. The shaft going through the center has a gear fastened to it, in which this gear runs enmesh with gears E. The case K has a gear fastened to the case in which the gears E run enmesh with it.

Now gear B runs enmesh over the top of the gears E. The plate C goes over in front of the gears that hold them all in place. Gear B that runs over the top of the gear E has a sprocket fastened to it.

The shaft that passes through the center is fastened to the motor which is the crank shaft. You will find it operates in this way. There is a brake band that goes over the case K that holds this case from turning when desired, that is locked by a foot brake.. The case H also has a brake over the top of it that is locked by a foot brake. The case H has pins fastened to it that go through the gears E and F.

The gear which is on the shaft D is fastened to the shaft. Now, when this gear on the shaft is turning your motor is running and it must turn when the motor runs, which it drives on the outer half of the gears E. As this is turning the gears in one direction, the gears F are turning in the other direction. That causes case K to revolve one way and the case H to revolve the other.

If you were to lock the brake band on case K you would hold the gear that is fastened to that case, but it will not allow either the case or the gear to turn. Then the gears E will revolve round over the top of the gear that is fastened to case K. As they revolve round the gear which is running over the top of the gears E will carry gear B round in the same direction with it, giving you first speed.

To get reverse, you will lock the brake band on case H that holds the pins to which the gears E and F are on, not allowing them to revolve round, but to stand still and turn as the gear D is turning in the same direction. You will find that the engine runs, the gears E are running in the opposite direction and the gears F are running in the same direction that the engine is running which runs the gear on the case that is fastened to it in the opposite direction, and this

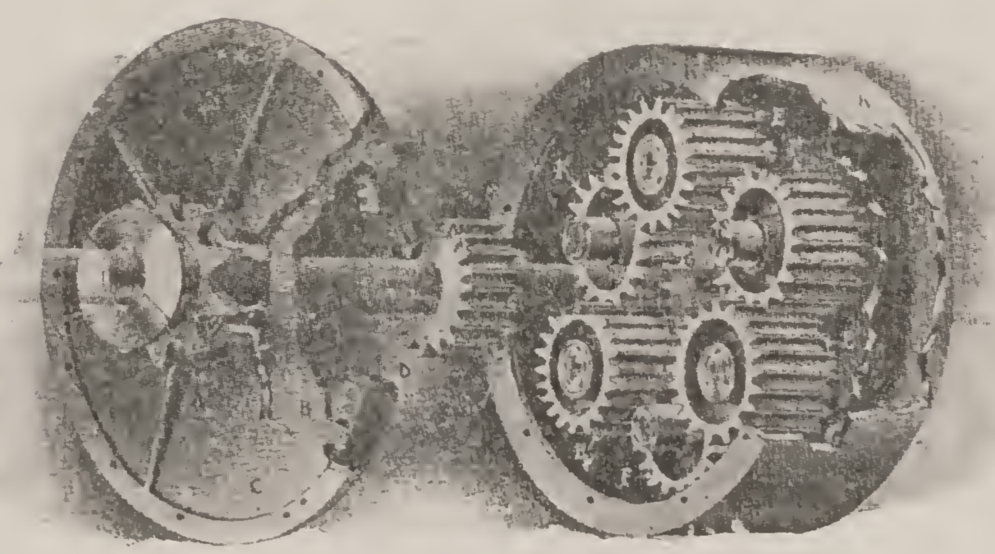


FIG. 36.

causes the case to revolve the same. This means nothing, except that the gears E turning in the opposite direction from the way the engine is running, cause the gear over the top to run in the opposite direction, and this means the reverse to your sprocket.

By locking a clutch, or throwing it in, which is done by a lever on the side of your car, it will allow the clutch to drop in that fastened to this shaft into a cone that is connected to the case K. Case K has got to turn then with the shaft with which the gear D is turning and as the gears try to turn in the opposite direction and also try to turn the case K the opposite direction from the way the shaft is turning it, it points the gears inside of this case in no direction only in the direction of the shaft, which shaft they all revolve together, giving you a direct drive straight through, and this is high speed.

I have explained this transmission exactly as the gears operate, which explanation I don't expect you will understand even after you have read it. However, if you come to the Automobile school, I am certain that I can show you, so that, by reading this over carefully and working with the transmission, you may be able to understand it thoroughly. It is almost a Chinese puzzle as we have it here, although you will find that it cannot be made any plainer on paper.

To take the Planetary Transmission apart on the Model 10 Buick, you must remove the universal joint shaft and inside of this you will find a set screw which must be removed. When doing this by removing the screw on the case you will find that the transmission will fall to pieces.

BEVEL GEAR DIFFERENTIAL

The next system that we take up is the bevel gear differential, which you will find is used on most of the cars nowadays, since it is a strong differential and stands a great deal of abuse.

There are very few people who understand the principle of the differential. Some owners of cars do not even know that they have got one.

The differential idea is for turning corners, allowing one wheel to stand still while the other one runs faster. If one wheel stands still, not turning at all, the other wheel turns twice as fast. This is done by the bevel gears which you will find inside.

The differential that you will find in Figure 37, shows you the gears as they are inside. The dark gears are the gears which you will find between the two master side gears. There is a master side gear on each side of these gears, although we only show one master side gear. This gear is fastened to the rear shaft. The gear that belong on the other side is fastened to the rear shaft. The dark gear you will find drives in the center between the two. Now the large master gear which you see on the outside part not finished, shows you the driving power of the whole differential. The bevel driving gear which is driving on the large master gear is driven through a universal joint through the propeller shaft from the transmission. This gear when revolving turns the master gear. The master gear turns the shaft round with it, which the four bevel gears that are placed on across, carries the side master gears along with it, both of them being carried in the same direction as the bevel gears in the center do not revolve on a straight pull, but, say that you were to turn a corner, you will find that the master gear on the side would stand still and the bevel gears would revolve in the same direction that the large master gear is turning. From this you can plainly see that the master gear on this side would have to revolve ahead of the bevel gears in the center, which would cause it to run at the speed of the master gear and at the speed of the bevel gears, which would be twice the speed that it would be running. If both side master gears were running with the large master gear and the center bevel gears standing still, then it would only run the speed of the master gear, which is half the speed that it would be running otherwise.

You will find that this differential stands a great deal of abuse, as the bevel gear has a great deal of strength. This particular differential is found in many different types of cars, although it is not the only make there is. We have two more makes, but only one of them is used. That is the spur gear. There is a universal differential which is not used whatever, as it did not prove satisfactory because they worked loose and caused too much noise. This differential works the same as a bevel differential does on a traction engine. That is its principle, to allow one wheel to stand still while the other one turns faster, in making the corners.

.If you want to experiment to see the principle of this, jack a car up, turn one wheel one way and you will notice the other wheel turns backwards. But if you start your engine and throw your vehicle in speed, you will find that both wheels run ahead. If you hold one of the wheels, you will find that the other wheel will run twice as fast. This proves to you that the differential is doing as I have just explained.

When the object of one wheel turns backwards when you turn the other ahead, you are not transmitting your power through the large master gear, but are transmitting it through the side master gear, which gear causes the bevel gear to turn in the same direction, while it causes the other master side gear to turn in the opposite

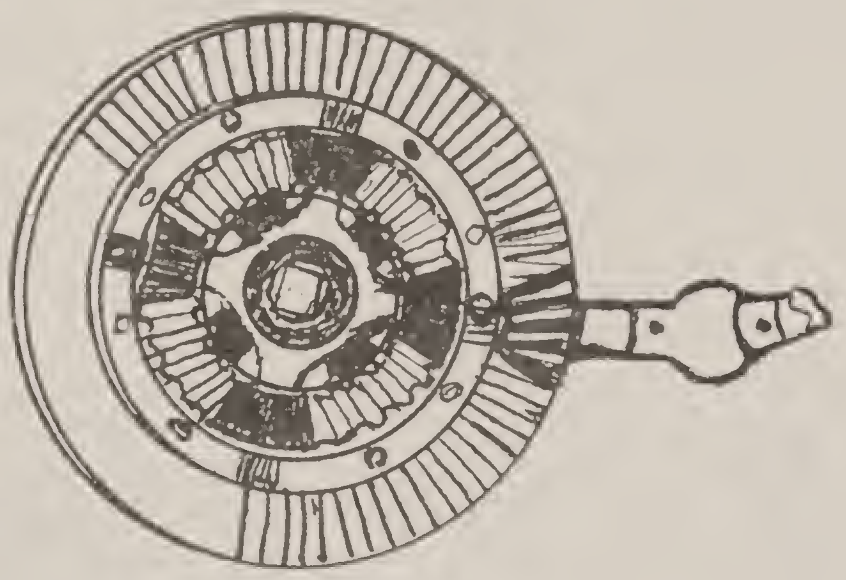


FIG. 37.

direction, and causes the rear wheel on the other side to turn backwards. When the power is transmitted through the large gear, the bevel gears are not turning and are pulling just as hard on one side as they are on the other. The two side master gears are turning with the center bevel gears, and both turning in the same direction. This you will find is the action of the differential.

If you were to get one wheel in a mud hole, the other being on good footing, the one in the mud hole would keep turning and the one on good ground would stand still. The only way to make the other one turn is to hold the one that is in the mud. This can be done by knocking out the pin of your brake rod on the brake band from the wheel that is on a good footing. Then lock your brakes so that the brake band will lock on the wheel that is in the mud without allowing it to turn, and the other wheel has got to turn, and you can drive out.

If you get in a mud hole, you can throw your lap robe or anything else, as hay, brush or any other stuff that will make a good footing, under your wheels and it will help you to get out. Sometimes by tying a rope or taking the straps off of your top and have a couple of men pull on the front of the car and starting your vehicle, it will help you to pull out of a mud hole.

When this bevel gear differential is put together, it should be packed with hard oil. The housing into which it goes must be filled with non-fluid oil up to the top. This whole differential must run in oil. The oil feeds from the differential over to the rear wheels through the axles. This sometimes feeds out and flies all over your wheel and brake band. To stop this you get a felt washer that goes in the hub over the axle. The wheel, setting up against the felt washer, will keep the oil from passing through the housing into the wheel and flying all over the wheel, getting it all oily and allowing your brakes to slip from oil on the brake band.

If you have trouble getting a wheel off, sometimes you can remove it by taking a block and placing it against the shaft and hitting it with a heavy sledge while a couple of men are pulling downward on the wheel. Should you not be able to get it off in this way, you can take a wheel puller and remove the wheel.

We do not put oil in the hub caps on the rear wheels. For when a car leaves the factory the front hub caps are generally packed with hard oil. I would advise you to remove the hard oil and fill with a non-fluid oil, for this oil will pass through the hub and oil your axle, while the hard oil will lay in the hub cap and your axle will become cut out by gum and grit.

We have five different kinds of axles with which you will become acquainted. There is the live and the dead axle, the similar floating and the three-quarter floating and the full floating. The similar floating axle is different from the full floating or the three-quarter floating, and the live axle is different from the dead axle. The dead axle is one which does not revolve and it is a double chain drive. The rear wheels turn on the axles. The live axle is one which carries the weight of the car on the rear axle, the wheels being fastened to the axles and the bevel side gears are also keyed to the axles. If you were to take these axles apart you must take your rear axle out from under the car, take it all to pieces in order to do any work with your differential. If any axle were to break, you will find that the car would have to be supported by a skid of some kind, such as a pole placed under the rear axle.

The similar floating axle is an axle which carries the weight of the car on bearings as well as the axle, but the wheels are fastened to the axles and also the axles are fastened to the differential. This axle is almost the same as the live axle.

In the three-fourths floating axle, you will find that the weight of the car is carried upon the housing, but the wheels are fastened to the axles and the shaft is fastened to the differential. The differential can be opened at the top, so that you can get in at the top to work on it.

In the full floating axle, the weight of the car is carried on the housing and the axle has nothing to do except to drive the rear wheels. The rear wheels are fastened to the housing so that the axles can be pulled out from both sides by removing the hub cap, so that you could pull your car in with another car without any axles in it whatever. This makes it a very easy matter to remove a broken axle by going to work and taking off the hub cap on the side of the one that is broken and pulling out the broken piece, removing the hub cap on the other side and push the other broken piece through. This way you can remove the other broken piece and place back the axle on that side and get a new one, shoving it in place so that you will be ready to go inside of 15 minutes from the time you meet with the accident, provided you have another one to replace it with. With the other axles it means from 3 to 5 hour's work.

This differential can be taken out of the housing without taking the housing apart by removing a case at the top, by simply removing the shaft and lifting the differential straight out.

SPUR GEAR DIFFERENTIAL

The next illustration which I shall explain to you is the Spur Gear Differential, shown in Figure 6. This figure shows you the differential as you would be looking at it if you stood behind the illustration. Also, it shows you a side view of the six-spur gears.

The two large gears A and B are the gears that are fastened to the rear axles. The gear F halfs runs enmesh with the Gear B, and

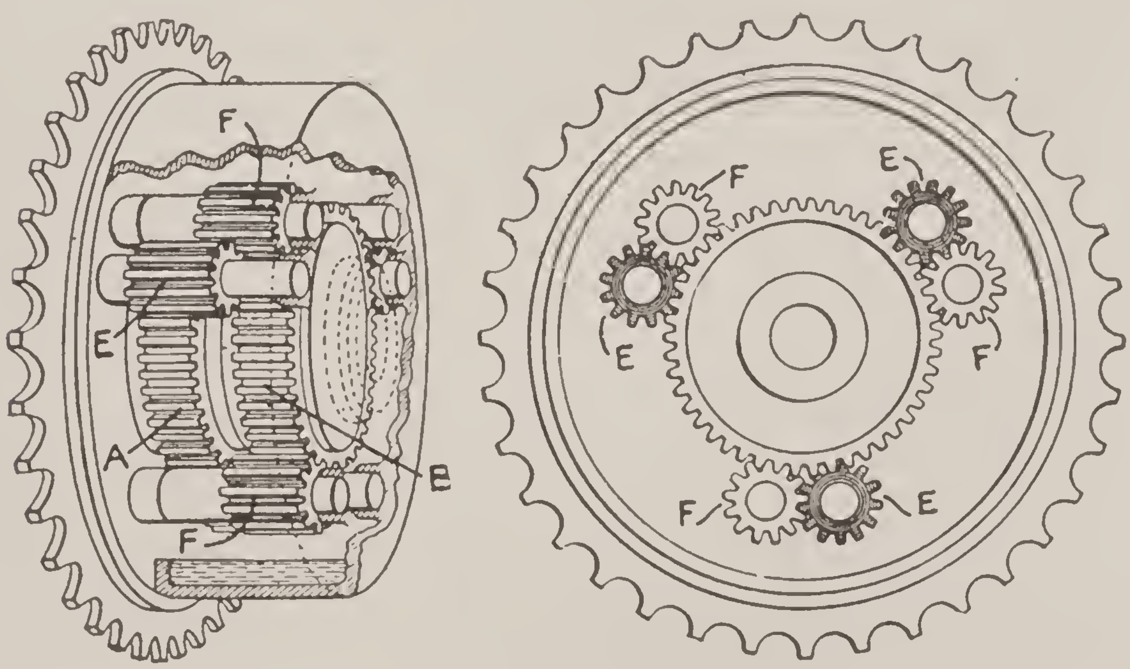


Fig. 6.

SPUR GEAR DIFFERENTIAL

the other half runs enmesh with the gear E. The other half of the gear E runs enmesh with the gear A. The same way with the other gears on this differential.

Now, when the power is being thrown upon the differential, it shows a large sprocket called the master sprocket, driven with a chain drive. When pulled ahead this will pull the pins that the gears E and F are on. This causes these gears to pass round with the sprocket gear. You will notice now that the gear E would try to turn ahead;

but if it did, Gear F would turn back, and if this took place, gear A would turn backwards while gear B turned ahead, which would be impossible. You will observe that it is just as easy to turn gear F ahead as it is to turn gear E ahead, so for this reason neither gear turns at all, but revolves round with the two gears A and B. This causes these two gears to turn in the same direction that both large wheels turn as they are connected to the shaft and the shaft fastened to these two gears would turn straight ahead.

Again, if we were to hold the wheel that is on the axle that is connected to the gear A and turn to the sprocket gear which would pull the case round with the pins fastened to it, you can see that the gear E would have to turn with gear A, as we would be holding it. Then the gear F would have to turn to the reverse, causing it to force gear B ahead of it. Now you have the speed of the gear F with gear B, and have the speed of the sprocket also. This would give you twice the speed on the gear B and your wheel would turn twice as fast, which it does in turning a corner. The same thing would take place if you were to hold the gear B. Then the gear F would have to turn ahead, causing the gear E to turn backwards, forcing gear A ahead of it, making gear A run twice as fast, which would cause the wheel that is on that side to run twice as fast, also. This would occur in making the swing the other way.

This differential does not stand as much abuse as the bevel, for the simple reason you will find the gears E and F are enmesh and the whole strain lies between these teeth. Under hard strain you will find these teeth give away. At such times you will find that this differential strips out. This differential is the same as the other. It must be packed with hard oil, and when put into the housing it must be filled with non-fluid oil.

FIRST AID IN ENGINE TROUBLE

Engine firing irregularly may be caused by:

(1) Broken down insulation on wires.
(2) Carburetor not properly adjusted, causing poor mix.
(3) Cracked spark plug.
(4) A defective connection at some part of the circuit.
(5) Gasoline feed partly choked.
(6) Moisture on spark plugs or water in oil case.
(7) Poor contact in timer.
(8) Spark coil not properly adjusted.
(9) Terminals in coil may be loose or damaged.

NOTE—Much irregular firing can be prevented by periodically cleaning the drain on the carburetor. (If gasoline tank has drain, clean it also.)

The next preventive, however, for avoiding an accumulation of dirt in the gasoline system is through the use of No-Shammy Funnels.

Engine emits hissing sound may be caused by:

(1) Broken spark plug.
(2) Cracked exhaust pipe.
(3) Loose union where exhaust pipe connects with muffler.
(4) Open compression tap.

Engine fires regularly, but is weak, may be caused by:

(1) Compensating valve on carburetor not working.
(2) Improper gas mixture.
(3) Insufficient lubrication.
(4) Poor compression caused by loose plugs or valves.
(5) Platinum contacts on coil may need cleaning.
(6) Reduced lift on exhaust valve.
(7) Silencer outlets may be stopped with mud or charred oil.
(8) Vibrator on coil may need adjusting.
(9) Weak spring on inlet valve.

Explosions in silencer may be caused by:

(1) Cylinder missing fire and pumping explosive charges into silencer, which ignite from heat of next exhausted charge.
(2) Exhaust valve stuck or does not seat properly.
(3) Gas mixture too weak to fire in cylinder.
(4) Inefficient spark.
(5) Over-retarded spark.

Knocking in the engine may be caused by:

(1) Defective lubrication.
(2) Fly wheel loose on shaft.
(3) Loose cylinder on crank case, due to nuts slacking off.
(4) Loose or worn bearings.
(5) Pre-ignition, due to carbon deposit.
(6) Spark too far advanced.
(7) Too rich mixture.

Exhaust pipe becomes red-hot, may be caused by:

(1) Clogged silencer.
(2) Driving with exhaust throttled.
(3) Driving with retarded spark.
(4) Driving in low gear too much.

Engine refuses to start, may be caused by:

(1) Broken or jammed gears.
(2) Dry cylinders.
(3) Battery plug not in position.
(4) Fouled or cracked spark plug.
(5) Gasoline shut off.
(6) Improper gas mixture.
(7) Improper ignition.
(8) Inlet valve stuck.
(9) Open battery switch.
(10) Poor compression.
(11) Water in cylinder caused by leak from water jacket
(12) Water in gasoline.

Engine runs properly but car drags, may be caused by:

(1) Clutch slipping.
(2) Dry or worn clutch leathers—may need renewing.
(3) Weak clutch springs.
(4) Brakes not completely released.

Engine stops suddenly, may be caused by:

(1) Broken spark plug.
(2) Disconnected electric circuit.
(3) Loose terminal.
(4) No gasoline.
(5) Trembler on spark coil stuck.
(6) Trouble at timer.
(7) Broken wire.

Gradual slowing up with misfiring may be caused by:

(1) Carburetor may be choked up with dirt at jet.
(2) Gasoline tank empty or air-bound.
(3) Gasoline valve partly closed.
(4) Fouled spark plugs, due to over or poor lubrication.

Explosions in Carburetor or inlet pipe may be caused by.

(1) Defective inlet valve spring.
(2) Inlet valve not properly closing.
(3) Leaking valves.
(4) Lean gas mixture.
(5) Spark too far retarded.
(6) Valves incorrectly timed.

Squeaks and their probable causes may be caused by:

(1) Brakes may be partly set.
(2) Lack of proper lubrication at friction surface.

Water in radiator boiling, causing over-heating may be caused by:

(1) Clogged radiator tubes.
(2) Clogged silencer.
(3) Defective pump.
(4) Defective water circulation.
(5) Fan not working.

TEMPERING SPRINGS

Take two quarts of boiled linseed oil, have your piece of steel red hot, not white heat, and dip piece of steel into the oil, take steel from the oil and hold it over the fire until oil catches fire on the spring, put back in the fire and warm enough so that it will burn again. Do this three times and you will be able to temper any ordinary spring. Cool in cold water.

RULE FOR BRAZING

First get one pint of brazing compound, one pound of granulated spelter, have your piece of iron red-hot and with a small ladle apply your brazing compound until it all melts and runs all around the work, then apply spelter until it thoroughly melts and runs into, keep turning the work while it is in the fire, do not get it too hot or you will burn the brass and kill its strength.

CONDITIONS THAT AFFECT IGNITION INDEPENDENT OF BATTERIES

When a gasoline motor misses explosions, nine times out of ten the operator assigns it to a weak battery. This is wrong, for there are a number of things that cause missing not the fault of the battery. Here are a few of them:

If mixture is lean, or does not contain enough gasoline vapor, the engine will miss and show a lack of power and in most cases will cause popping or back firing in the carburetor.

If mixture is over-rich with gasoline vapor, the engine will run poorly and show a lack of power. This is usually accompanied by an exhaust of black smoke and foul smell.

Loose connections in wiring will cause missing.

Be sure that connections on motor, cell, and battery are carefully and securely made. This is very important.

Timers on some motors are so designated that poor contacts are caused as soon as the timer wears. Others are of such design that an accumulation of oil or dust prevents clean metallic contact. Either of these conditions will prevent regular running and cause missing.

Cracked or leaky spark plugs cause missing.

Leaky valves in engine cause irregular running and missing.

Improper adjustment of spark coil may cause so severe a strain on the battery as to prevent its giving satisfactory service. It causes missing and prevents the engine from responding quickly to its throttle. Proper adjustment of coil will overcome this.

SUGGESTIONS

(1) Stop engine when you leave your car. This will save batteries, and prevent busybodies from starting trouble.

(2) Use plenty of speed when ascending hills. This prevents pounding as well as the trouble of changing clutch to low gear. If pounding should occur, change to low gear immediately.

(3) When starting motor, see that clutch is out. You will save runaways by observing this.

(4) Retard spark before cranking. The engine may fire back and injure you. If you practice the left hand starting method, back firing is less dangerous.

(5) Cylinders should have a good supply of high quality oil. This will help prevent the motor from over-heating and burning the regular supply which will cause the piston rings to cut the cylinders,

(6) Inferior grades of lubricating oil cause carbon deposits on piston head, on points of spark plugs, and on combustion chamber walls. This carbon on the spark plug may form a short circuit, which will interfere with ignition. If this deposit becomes too thick, it will hold sufficient heat from one explosion to another to cause pre-ignition.

(7) When the motor is primed, if it does not start after being turned over the compression three or four times, there is no use to continue cranking, something is wrong.

(8) Throw off the battery switch when engine is not running. It will lengthen the life of the batteries.

(9) Turn on battery switch before cranking engine. Remember this will save labor and bad temper.

(10) Regular inspection of your engine will prevent much trouble and expense.

(11) Throw out clutch at sharp curves and corners. It will prevent accidents and skidding, which wears tires.

(12) It is not good practice to turn down the lights of an acetylene lamp. Better turn off gas and blow out flame instead of allowing it to die down. This keeps the small holes free from soot.

(13) Well inflated tires have longest lives. Full tires present less wearing surface to the road, and there is less risk of cuts and punctures.

(14) Back firing in a two-cycle engine is generally caused by lean gas mixture.

(15) Carry a flashlight for working around an auto at night. It gives a brilliant light and is perfectly safe around inflammable or explosive materials.

(16) Never allow your motor to run at its maximum speed when car is idle. This puts an unusual strain on many parts of the engine and causes unnecessary wear.

ANTI-FREEZING SOLUTIONS FOR MOTOR COOLING SYSTEMS

Mixing 20 per cent wood alcohol gives gravity of 97 and will freeze at 5 above, while same quantity of denatured alcohol will freeze at 16 above.

USEFUL INFORMATION

To Temper Steel Very Hard.—Water, 4 quarts; flour, 1 part; salt, 2 parts; mixed to a paste. Heat the steel until a coating adheres when dipped in the mixture, then heat to a cherry red and cool in cold soft water. The steel will come out white and very hard.

To Temper Steel on One Edge Only.—Dip the edge to be tempered into hot lead until proper color, then temper in ordinary fashion.

To Drill Hardened Steel.—Cover your steel with melted beeswax. When coated and cold, make a hole in the wax with a fine pointed needle or other article the size of the hole required, put a drop of strong nitric acid upon it; after an hour rinse off and apply again; it will gradually eat through.

A mixture of 1 ounce of sulphate of copper, ¼ ounce of alum, ½ teaspoonful of powdered salt, 1 gill of vinegar, and 20 drops of nitric acid will make a hole in the steel that is too hard to cut or file easily.

A small hole drilled at the end of a crack in sheet steel will stop it from growing longer.

Acid Tests for Iron and Steel.—A simple acid test for iron and steel is made as follows: The sample to be tested should be filed smooth or polished. Then place it in dilute nitric or sulphuric acid for from 15 to 20 hours; then wash and dry sample. The best steel then has a frosty appearance, ordinary steel has a honeycombed appearance, and iron presents a fibrous structure in the direction in which it has been worked.

Annealing Steel.—For small pieces of steel, take a piece of gas pipe, 2 or 3 inches in diameter, and put the pieces in it, first heating one end of the pipe and drawing it together leaving the other end open to look into. When the pieces are of cherry red, cover the fire with saw dust, use a charcoal fire, and leave the steel in over night.

In Turning Steel or Other Hard Metal.—Use a dip composed of petroleum, 2 parts, and turpentine, 1 part. This will insure easy cutting and perfect tools when otherwise the work would stop, owing to the breakage of tools from the severe strain.

Tempering Recipes.—Rosin, 2 lbs.; pitch, 11 lbs.; melt together and dip the hot steel into it.

Salt, ½ cupful; saltpeter, ½ ounce; alum, pulverized, 1 teaspoonful; soft water, 9 gallons. Never heat above a cherry red nor draw any temper.

By melting together 1 gallon spermaceti oil, 21 lbs. tallow, and ½ lb. wax, a mixture is obtained very convenient for tempering any kind of steel article of small size. Adding 1 lb. rosin makes it suitable for larger articles.

To Harden Gravers.—Heat in charcoal dust (not too hot) and plunge into a box of wet yellow soap. This renders the end of the graver very hard and very tough.

Strong sal soda water or soapy water is much better than clean water to use where water cuts are being taken, either on lathe or planer. When cutting brass, sweet milk is recommended as being better than either of the foregoing.

Permanent Whitewash.—Slake ½ bushel unslaked lime with boiling water, keeping it covered during process; strain it, and add a peck of salt dissolved in warm water, 3 lbs. ground rice boiled in hot water to a thin paste, ½ lb. powdered Spanish whiting, and a pound of clear glue, dissolved in warm water, mix well together and let stand for a few days. When used put it on as hot as possible.

Cure for Burns.—Slake a lump of quicklime in water, and as soon as the water is clear, mix with linseed oil and shake well; this will form a thick, creamy substance. Bottled it will keep for months.

Use of Turpentine for Wounds.—The machinist often cuts or bruises his hand and by having a small bottle of turpentine handy he can at once bathe the injured part which will relieve the soreness and perhaps protect from blood poisoning.

Case Hardening Mixture.—3 prussiate of potash, 1 sal-ammoniac; or 1 prussiate of potash, 2 sal-ammoniac, 2 bone dust.

Automobile Horsepower.—The horse power of gasoline automobiles adopted by the Association of Licensed Automobile Manufactures (A. L. A. M.) is as follows:

$$\text{Horsepower} \frac{\text{box x bore x number of cylinder.}}{2\frac{1}{2}}$$

For example, an automobile has 6 cylinders, the bore of each of which is 5 inches. The horsepower of such a car would be:

$$\frac{5 \times 5 \times 6}{2\frac{1}{2}} \text{—60 H. P.}$$

To Solder Without Heat.—Brass filings, 2 ounces; steel filings, 2 ounces; fluoric acid, ¼ ounce. Put the filings in the acid and apply the solution to the parts to be soldered, after thoroughly cleaning the parts in contact, then press together. Do not keep the fluoric acid in glass bottle, but in lead or earthen vessel.

To Soften Steel.—Cover it with clay, heat to a cherry-red in a charcoal fire and let cool over night in the fire.

To Soften Hard Cast Iron for Drilling.—Heat to a cherry-red, having it to lie level in the fire. Then with a pair of cold tongs put on a piece of sulphur a little less than the size of the hole to be drilled. This will soften the iron entirely through, providing it is not too thick.

To Sharpen Reamers.—Use a stone on face and top of cutting edge, taking care to keep stone perfectly flat.

To Sharpen Dull Files.—Immerse them in diluted sulphate acid until cuts are sufficiently deepened.

LIST OF TOOLS

1 blow torch.
2 soldering irons, two sizes.
1 set of eight wrenches, to 1 inch.
1 set of carbon scrapers.
3 screw drivers, three sizes.
3 cold chisels, three sizes.
3 punches, three sizes.
1 set bearing scrapers.
2 monkey wrenches, 8 and 10 inches.
1 Billings wrench, 8-inch.
2 lbs. solder.
2 pints muriatic acid.
1 8-lb. vise.
1 volt meter.
1 tire gauge.
1 valve tap and die.
2 hammers, light and heavy.
1 sledge hammer, 5 lbs.
1 roll of tape.
1 spool of copper wire.
1 set auto cleve wrenches.
1 breast drill.
1 set drills, 1/8 to 3/4.
5 gals. transmission oil.
5 gals. non-fluid oil.
5 gals. International cylinder oil.
5 gals. Fidelity oil.
25 lbs. hard grease.
1 ball asbestos wicking.
1 ball lamp wicking.
2 Trymo wrenches, 6 and 10-inch.

International oil and Fidelity oil mixed makes pan hard oil.

EIGHT-CYLINDER CADILLAC

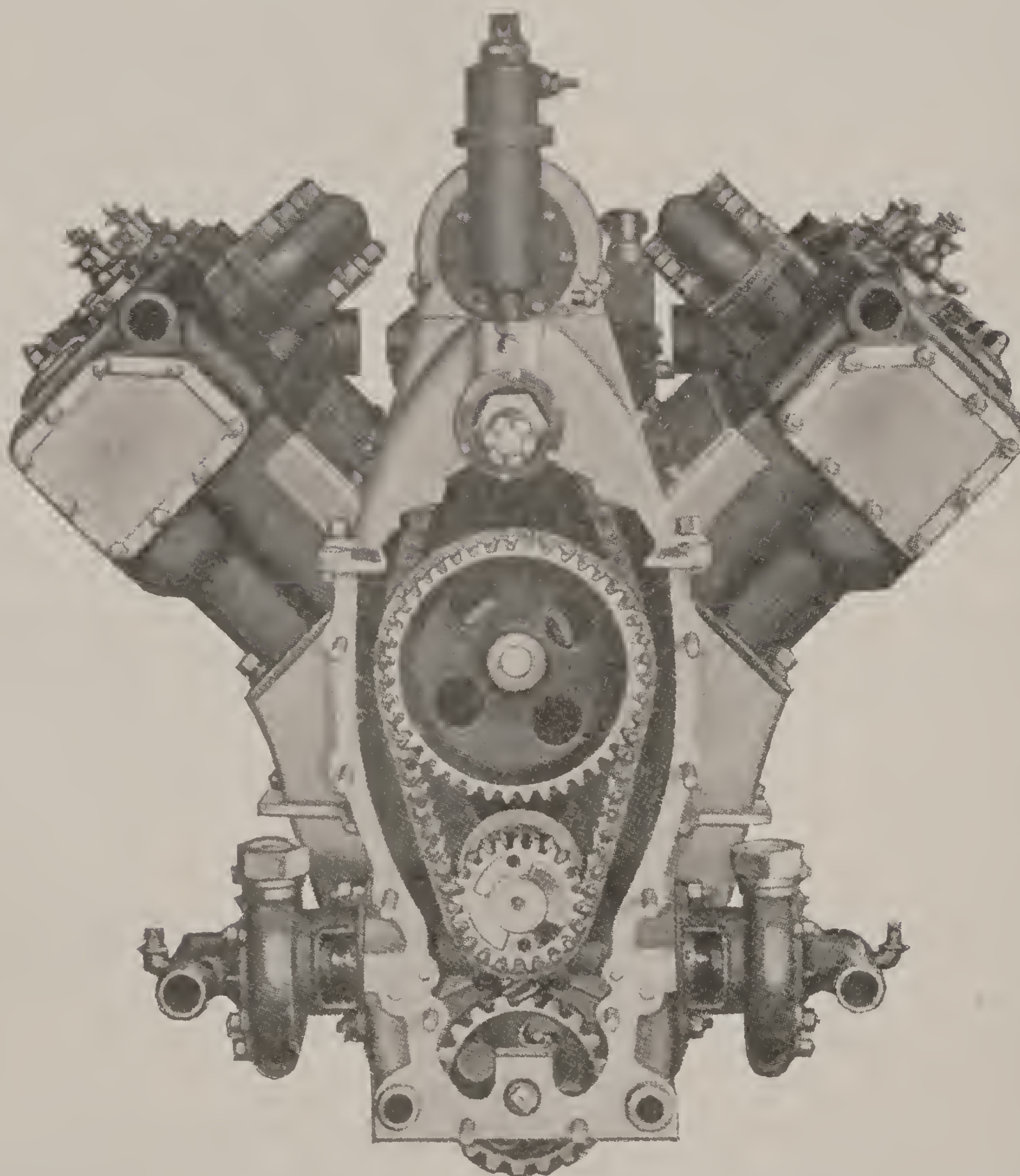
The Cadillac Motor Car Co. is using an eight-cylinder motor as its stock equipment, this marking the debut of this type of motor in the stock-car field in America. The motor is what has been known as the V-type developed some years ago by the DeDion Bouton company in France, and marketed since then by that company as stock models. The eight cylinders are arranged in two groups of four each, and these groups are mounted at 90 degrees to each other on the crankcase.

Although an American eight-cylinder motor comes as a distinct innovation, the principle is not new, not even so far as the automobile industry is concerned, and if we turn to aviation we will find that this design of motor has been successfully used by one of the best known French makers.

Naturally, the first question which will be asked is why the addition of two cylinders will make such a justifiable difference in performance as compared with a six. In the eight there are eight power impulses during each complete cycle of two crankshaft revolutions; that is, there is a power impulse every quarter turn of the crankshaft and thus there is no intermission between them, but rather an overlapping so complete that the turning effort is practically constant. In the six there is a power impulse every one-third revolution of the crankshaft, and though there is always a turning effort upon the crankshaft, it has more fluctuation due to the longer interval between impulses. In the four-cylinder engine an impulse occurs every half revolution, and there are obviously periods in the cycle when there is no appreciable force exerted by any of the pistons. The flywheel is then called upon to carry the shaft over these power lapses.

Due to this continuous turning effort, the six-cylinder motor has rapidly come into prominence, and the eight has an even more uniform torque.

Of course, the simplest arrangement of eight cylinders would be all in line just as the six are arranged or the four. But this would be impracticable, due to the extreme length and also to the abnormally long crankshaft which would be necessitated, while the crank-



CADILLAC EIGHT-CYLINDER V TYPE MOTOR

This photographic reproduction shows the front end of the new Cadillac eight-cylinder motor, which the company will use in its new cars. There are two groups of cylinders, each a block casting of four cylinders, mounted at 90 degrees to each other. The cylinders are 3⅛-inch bore and 5⅛-inch stroke. The piston displacement is 314 cubic inches; the horsepower rating is 31.25. In dynamometer tests the motor shows 70 horsepower at 2400 r.p.m. The crank-shaft is identical in design with that used in a four-cylinder car, and the camshaft carries the same number of cams as in a four-cylinder design. This new motor weighs approximately 60 pounds less than the four-cylinder Cadillac engine used this year. There is but one carburetor used.

Front View of King V-type eight-cylinder motor with timing gear cover removed, showing silent chain-drive. Note mounting of ignition distributor in center; also compact, accessible design of motor.

case for such an engine would be very heavy. To eliminate these difficulties the cylinders are arranged in two sets of four opposite to each other at an angle of 90 degrees, the same angle as it would be necessary to set the two series of four crankshaft throws were the cylinders arranged all in line. This placing of the cylinders in sets at an angle of 90 degrees to each other gives the V form.

Arranged in this way, the eight-cylinder motor is no longer than a four-cylinder one of equal bore. As compared with a six, it has about 30 per cent. less length, resulting in a shorter crankcase—a weight reduction factor. In addition, its crankshaft is of the same form as that of a four, the throws being all in one plane, whereas those of a six crankshaft are in three planes, it is a simpler manu facturing job. Further, the shorter shaft is less given to periodic vibration, the camshaft is also shorter and less prone to whipping.

Considering the weight of a six and an eight, the shorter crankcase, shorter crankshaft and camshaft, lighter reciprocating parts and flywheel give the latter a distinct advantage, considering that both engines have the same power. In the Cadillac case, the new motor has proven to be fully 60 pounds lighter than the four-cylinder engine formerly used. This is because it is shorter and has lighter reciprocating parts.

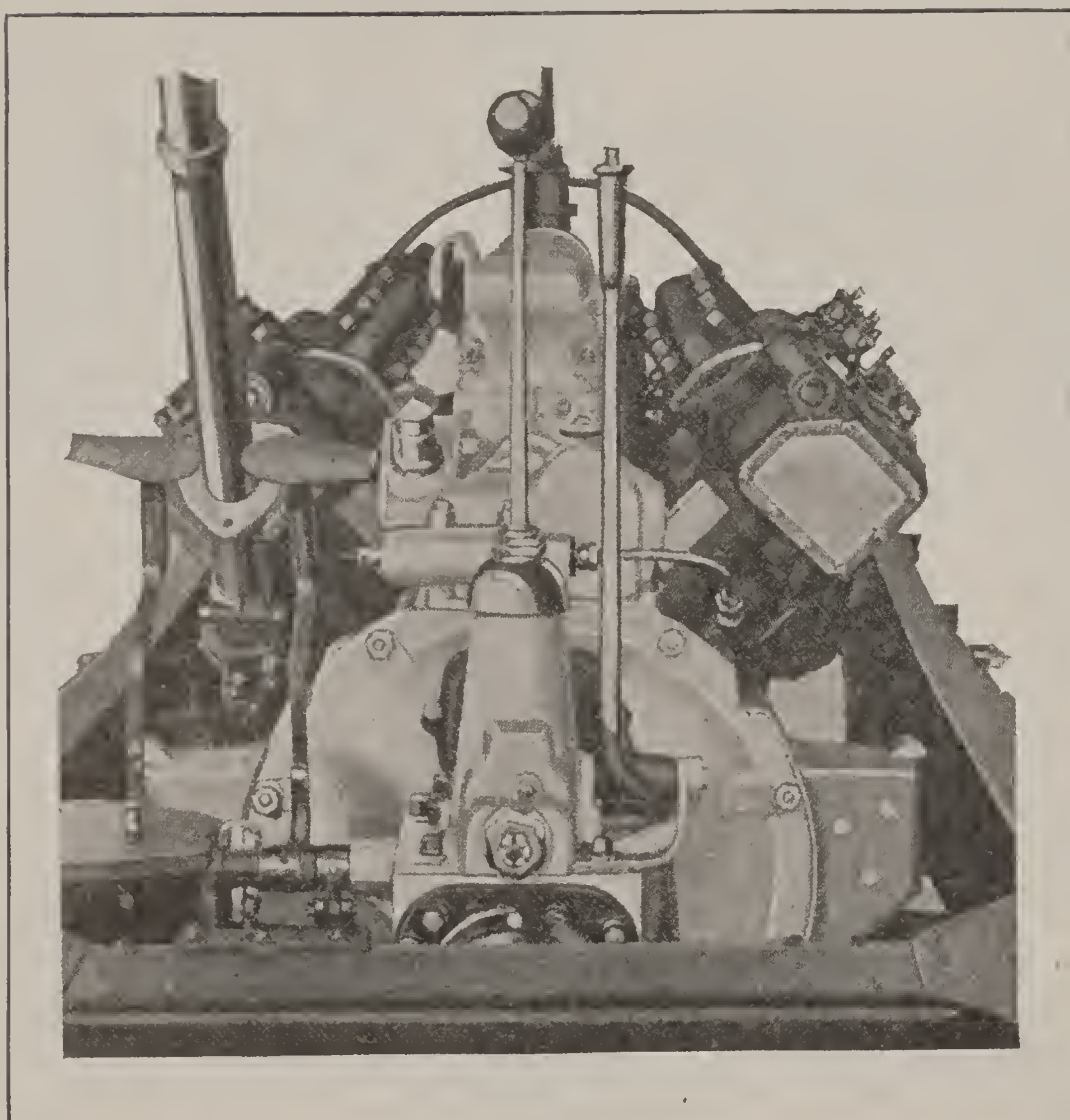
Because each set of cylinders may be cooled separately and due to the angle of the jackets there is no chance for any of the water to get into pockets, the cooling of a V-shaped eight is superior to that of a six or a four. The neutral tendency is for the water to flow upward through the jackets. Further, the water tends to rise to the hottest points of the jackets.

Aside from the purely mechanical advantages of the newset type of gasoline motor, the car owner is specially interested to know just how these above-mentioned advantages affect the working of the car so far as the actual driving of it is concerned. It is only natural for the average man to say to himself that perhaps the eight is theoretically superior to the six, but that when it comes to actual road work there is probably little difference.

ON THE ROAD

The writer must admit that prior to some actual road work with the new Cadillac he was somewhat inclined to be in the skeptical division and questioned the appreciable advantage of tacking on two extra cylinders. A 60-mile run over rolling country where hills abounded, some quite steep, resulted in complete conversion to the eight and great surprise at its performance, however.

Gearshifting proved to be almost an unnecessary operation, speeds anywhere from 2½ to 55 or 60 miles an hour being attainable on high gear. The quick acceleration from slow running to passenger train travel with no apparent effort whatever was truly remarkable. Bad stretches of road, turn outs for slow-moving vehicles and other traffic obstructions very rarely made it necessary to drop into second gear. Nor was this high gear driving done with any effort; the car controlled with the throttle alone just as if it were an electric responding to a current control lever. There was an undeniable feeling of



REAR VIEW CADILLAC MOTOR, SHOWING DELCO UNIT IN V CYLINDERS.

The angular space between the two groups of cylinders affords ample space for the fan and tire pump in front, the carburetor near the middle and the Delco unit at the rear. There is a separate exhaust pipe for each cylinder group, the flanged ends on these pipes being shown. This illustration shows the compact gearbox, a unit with the motor. For next year a multiple-disk, dry-plate clutch is used, composed of fifteen high-carbon steel plates 7.75 inches in diameter. The set of plates driven by the flywheel are faced with wire-mesh asbestos.

security in driving the car, for the idea of killing the motor does not enter your mind the reserve power is so great.

S. A. E. HORSEPOWER 31.25

Considering the Cadillac motor in detail, one is struck with the high speed, high efficiency machine which has been produced almost without precedent or previous experience with this type. The two sets of four cylinders are each block cast and present much the same general appearance as any other block of four. The bore is 3⅛ inches and the stroke 5⅛ inches, giving a total piston displacement of 314 cubic inches. The S. A. E. formula, which is really not applicable to this motor, gives it a rating of 31.25 horsepower. On dynamo meter tests it has developed 70 horsepower at 2,400 revolutions per minute.

CONNECTING RODS IN PAIRS

The blocks of cylinders bolt to the copper-alloy aluminum crankcase which is common to both and which is split horizontally into upper and lower sections, the lower portion being the oil base. The upper half carries the crankshaft which has three main bearings. Both sets of connecting-rods connect to this shaft, one throw bearing taking care of a pair of rod ends, in opposite cylinders. In order for both to fasten to the same bushing, one rod has a yoked end, the other rod end fitting within the yoke arms. Two caps are thus required for the yoke rod, one for each arm of the yoke. These fit around the outer part of the bushing, gripping it rigidly, due to the cap bolts and in addition pins go through the rod into the bushing so as to insure the two moving together. The other rod fits around the bushing within the yoke and is free to turn on the bushing. Thus in operation the bearing for the yoke-end rod is the inner surface of the bushing against the shaft, while that of the other rod is the other surface of the bushing. These bearings have babbitt linings in reinforced phosphor bronze shells. Thus there are four connecting-rod bearings on the crankshaft just as a four-cylinder motor would have. The length of the crankshaft to the outer ends of the end bearings is 26 1-16 inches.

Directly above the crankshaft is the single camshaft with eight cams, one operating two opposite inlet valves or two exhausts as the case may be. The cam assembly is on the underside of a plate which bolts to the top of the crankcase between the two blocks of cylinders. Pivoted to this plate also are the small arms which are interposed between the ends of the push rods and the cams so that the lift will be straight upward instead of having a side thrust component. The camshaft has five bearings.

Vertically in line above the camshaft and crankshaft is the generator shaft which drives the fan and the combined motor-generator mounted on top of the camshaft plate and between the cylinder blocks, and also carries a gear which may be meshed with that of the tire pump carried at the forward end of the motor.

Both camshaft and generator shaft are driven by silent chains completely housed at the front end. The camshaft carries two sprockets, the outer carrying the chain running down to the crankshaft sprocket and the inner driving the chain which passes around the generator shaft sprocket above.

At the front of the engine and below the crankshaft is a transverse shaft driven from the crankshaft by spiral gears. A centrifugal water pump is located on either end of this shaft, one taking care of each block of cylinders.

LIGHT WEIGHT PARTS

In order to secure the accurate balance necessary to a high speed motor of this type so that it will be practically free from vibration, the pistons and connecting-rods are machined to very close limits. Uniformity of weight is important. Remarkable lightness of these parts has been attained due to the use of a special alloy steel for the rods which has great strength with extreme lightness, and also to the special form of the cast iron pistons, each of which has three ring grooves with three thin steel rings per groove. The wrist pins are fixed in the connecting-rods and oscillate in the pistons. They are constructed of chrome nickel steel tubing, case hardened and ⅝ inch in diameter.

As another indication of the refinement to which this motor has been subjected, the inlet valves are of tulip shape so as to facilitate the intake of the gas, while the exhausts are of the flat type and of tungsten steel.

ORDER OF FIRING

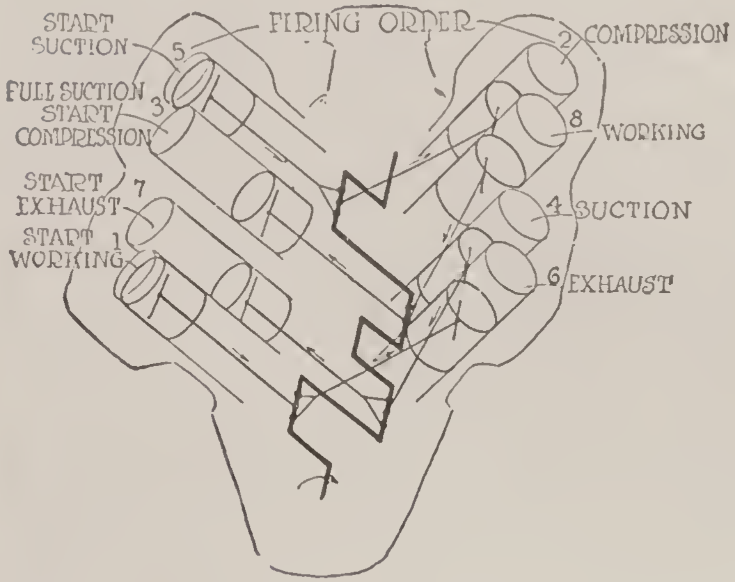
In firing, the order alternates from one side to the other, so that there is a power impulse first from a cylinder on one side followed by an impulse from a cylinder on the opposite side. The order of firing is indicated below:

Front
6X — X1
4X — X7
8X — X3
2X — X5
Rear

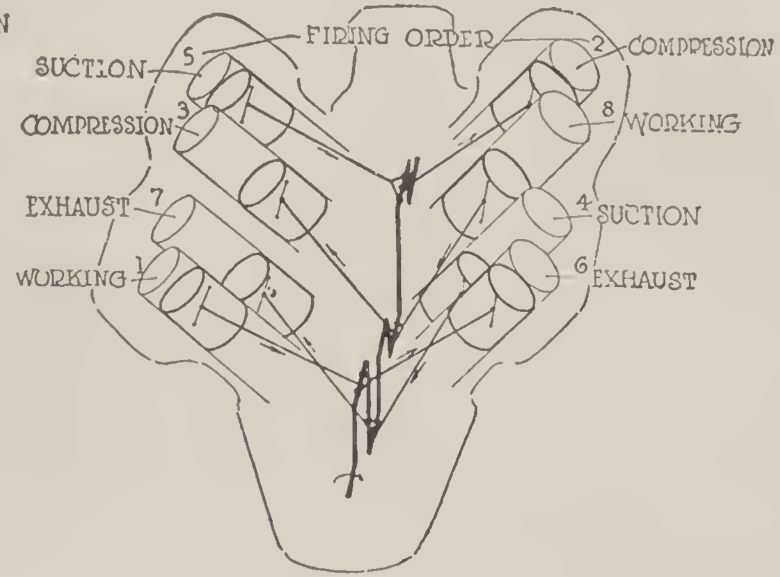
That is, No. 1 cylinder on the right fires first, then No. 4 on the left, No. 3 right, No. 2 left, and so on. As to the timing, the inlet valves open at top dead center and close 45 degrees after bottom dead center, while the exhausts open 45 degrees before bottom dead center and close at top dead center.

The Cadillac single-jet carburetor, specially adapted to this type of motor, is used. It occupies a position midway of the engine and between the cylinder blocks. A form of U manifold runs from it to the two cylinder blocks, the distribution to the various cylinders being done within the casting.

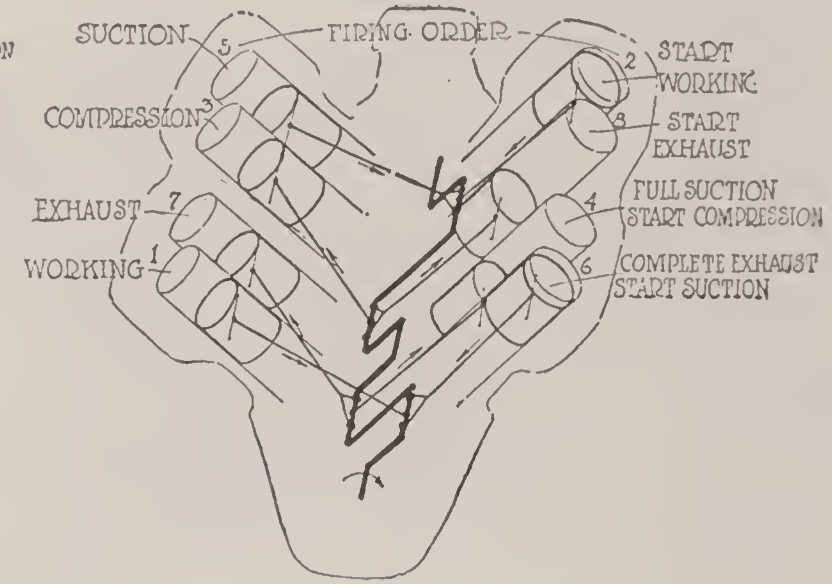
An entirely new feature to automobiles is the application of thermostatic control to the temperature of the cooling water, so that, in running, this water is maintained at nearly a constant temperature. In principle this thermostatic regulation is the same as the form used in connection with the heating systems of houses.



Showing the relative positions of the pistons and what is taking place in each cylinder when No. 1 cylinder commences its working stroke. All pistons on the left are either all the way up or all the way down, while all four on the right are midway



The order of events in the cylinders when the plane of the throws is vertical. The various parts of the cycle are well under way in the cylinders. The function that each cylinder is performing is indicated in the lettering

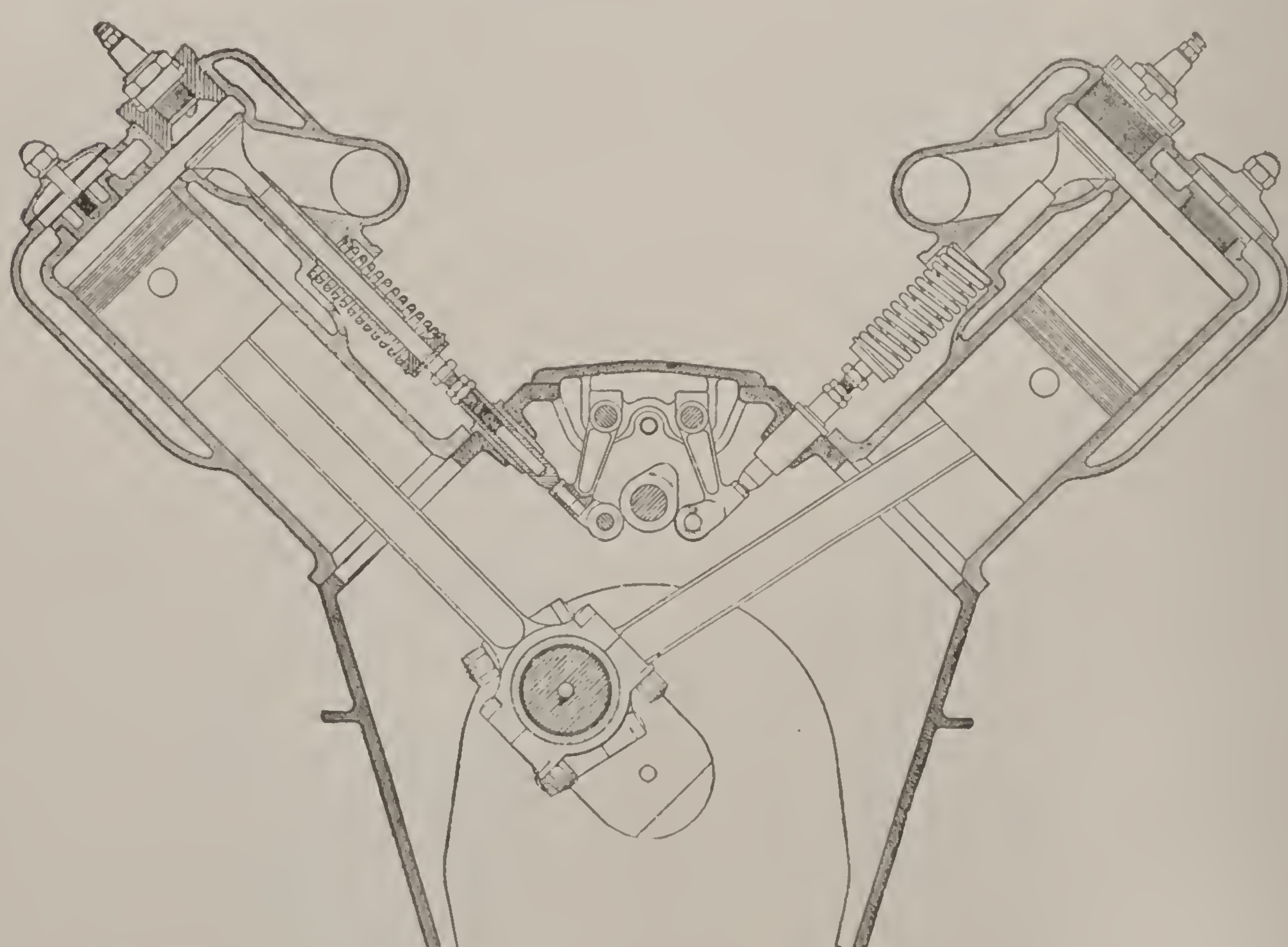


The shaft has now revolved through 90 degrees and the piston positions of the two sets are just the reverse of what they were in the first diagram. Those on the left are midway of their travel. The fourth cylinder in the right block is just firing

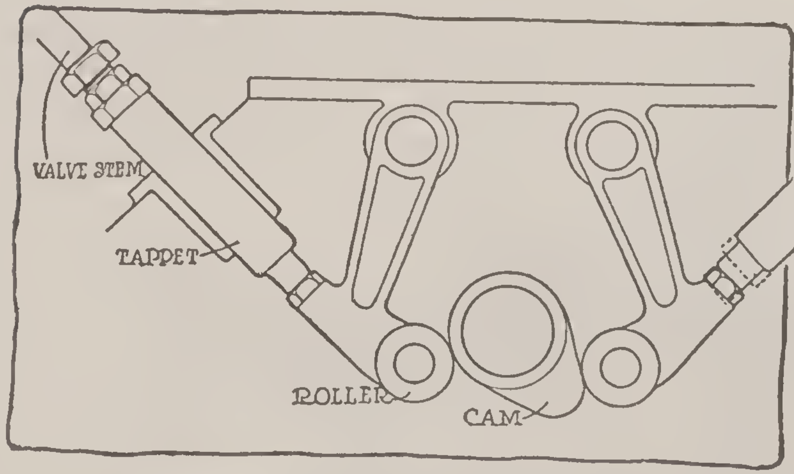
THERMOSTATIC CONTROL

In the the Cadillac application, there is interposed in the water pump line for each set of cylinders a thermostat which is simply a small coiled copper tube containing a liquid which expands or contracts in accordance with the temperature, thus slightly lengthening or contracting, its total movement being 1/4 inch. This thermostat is in connection with a valve so that when it expands, it raises the valve from its seat, this valve controlling the flow of water to the radiator from the pump. A by-pass connects with the water jacket of the carburetor, and when the engine is started, the water is naturally cold. Therefore, the thermostat is contracted and its valve on its seat. Thus the radiator water is shut off, the circulation being simply through the water jackets of the cylinders, through the by-pass to the carburetor jacket and thence back to the cylinders.

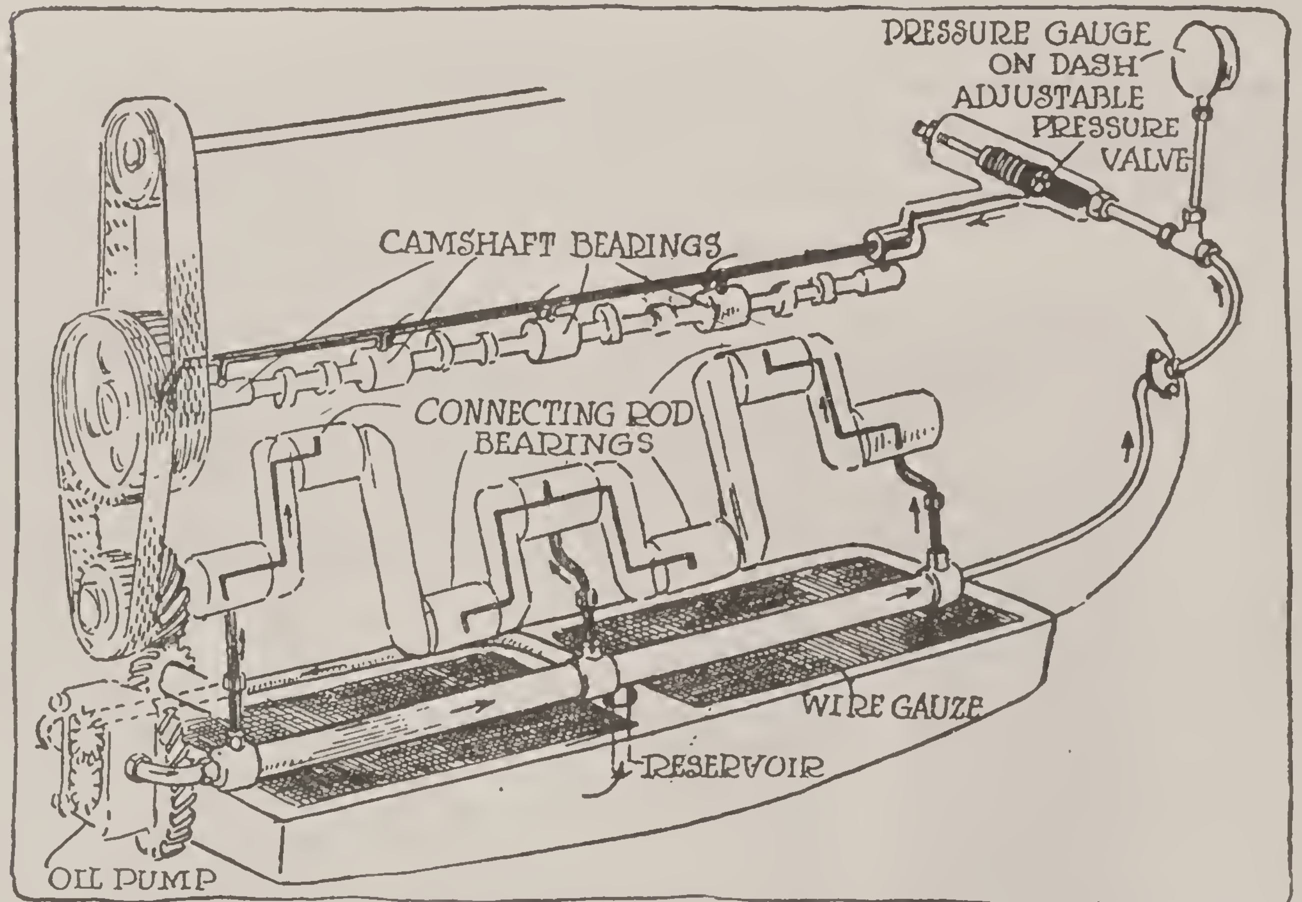
There is thus only a small part of the water circulating, and when this heats up, the thermostat begins to expand and lift its valve from its seat, letting the radiator supply flow into the system. This action continues back and forth so that the water temperature is nearly constant.



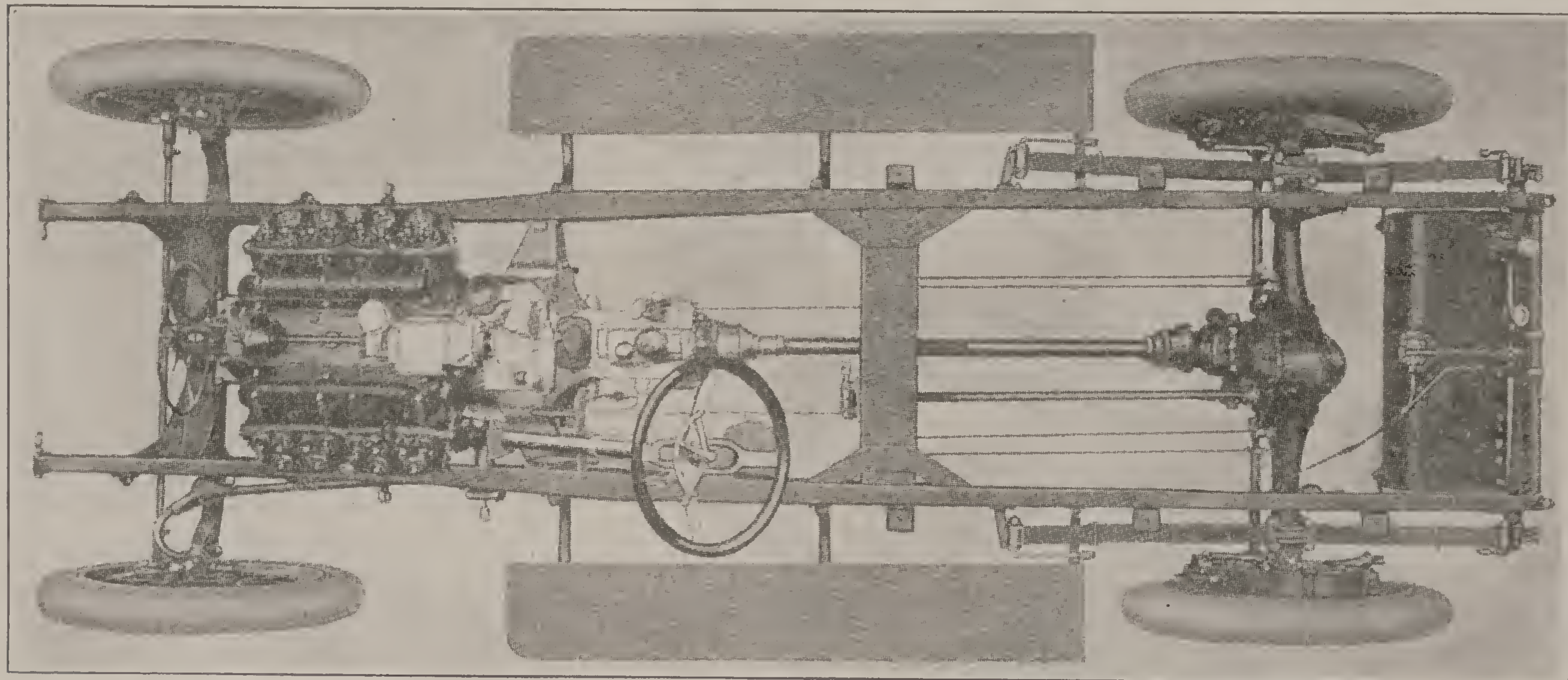
Cross-section of Cadillac eight-cylinder motor with the cylinders mounted in two groups of four cylinders each at an angle of 90 degrees. The single camshaft is located directly above the crankshaft, and the means whereby one cam operates the two intake valves for the opposite cylinders is shown. Note the tulip-shaped intake valves, this design of head giving a free flow of inrushing gases



The valve operating mechanism of the Cadillac motor, showing how one cam operates two opposite valves. The cam bears against the rollers in the ends of the small arms, which are pivoted to the plate above and which are interposed between the ends of the push rods and the cams, so that the lift will be straight upward instead of having a side thrust component. Adjustment of the valves is obtained in the usual way by lengthening the tappet. The upper part of the tappet screws into the lower and the two are locked by a nut. The position of the cylinders makes the valves extremely accessible



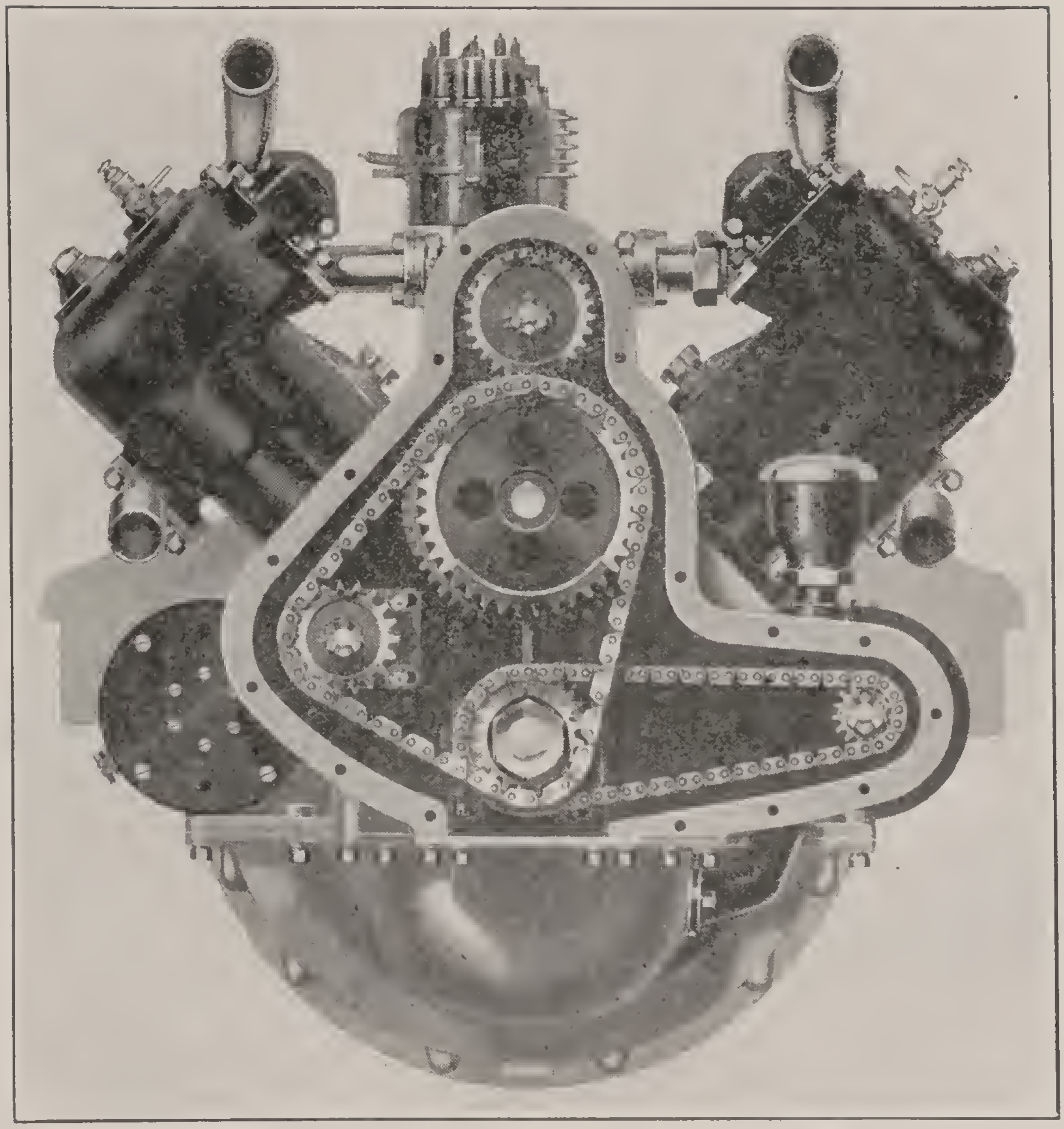
Lubrication of the eight-cylinder Cadillac motor. The pump draws the oil up from the reservoir and forces it through the pipe running along the inside of the crankcase. Leads run from this pipe to the crankshaft main bearings and thence through drilled holes in the shaft and webs to the rod bearings. It also is forced from the reservoir pipe up to the pressure valve, which maintains a uniform pressure above certain speeds, and then overflows from this valve to a pipe extending parallel with and above the camshaft. Leads from this latter pipe carry the oil by gravity to the camshaft bearings and chains. Pistons, cylinders, etc., are lubricated by the overflow thrown from the rods



CADILLAC CHASSIS, SHOWING EIGHT-CYLINDER MOTOR WITH UNIT GEARBOX.

For next year the Cadillac company has discarded the four-cylinder motor and is using an eight-cylinder design, which gives a very compact power plant, one actually shorter than the four-cylinder predecessor. The small flywheel is entirely enclosed and the three-speed gear box is a unit with the motor. For the first time this company has placed the steering wheel on the left with center control. A single-reduction Timken axle design is used with a set of spiral bevel gears instead of the conventional bevel type. The Delco electric system is continued. The wheelbase is 122 inches, or 2 inches longer than this year.

THE KING EIGHT



Front View of King V-type eight-cylinder motor with timing gear cover removed, showing silent chain-drive. Note mounting of ignition distributor in center; also compact, accessible design of motor.

POWER PLANT VERY SHORT

Compactness is also to be noted, for the power plant unit is really practically the same length over-all as the four-cylinder King engine. In fact, for test purposes, one of these eights has been installed in a standard four-cylinder chassis without making any changes save the removing of the four-cylinder power plant. As a result of this compactness and lightness of parts, the engine is said to weigh approximately the same as the four. Of course, they are smaller cylinders, the four-cylinder motor having a bore of 3 15-16 inches.

In the general motor design, the aluminum crankcase is common to both blocks of cylinders, the upper half carrying the crankshaft, and the lower part forming the oil pan. The removal of this pan gives access to the bearings just as in any two-part crankcase design.

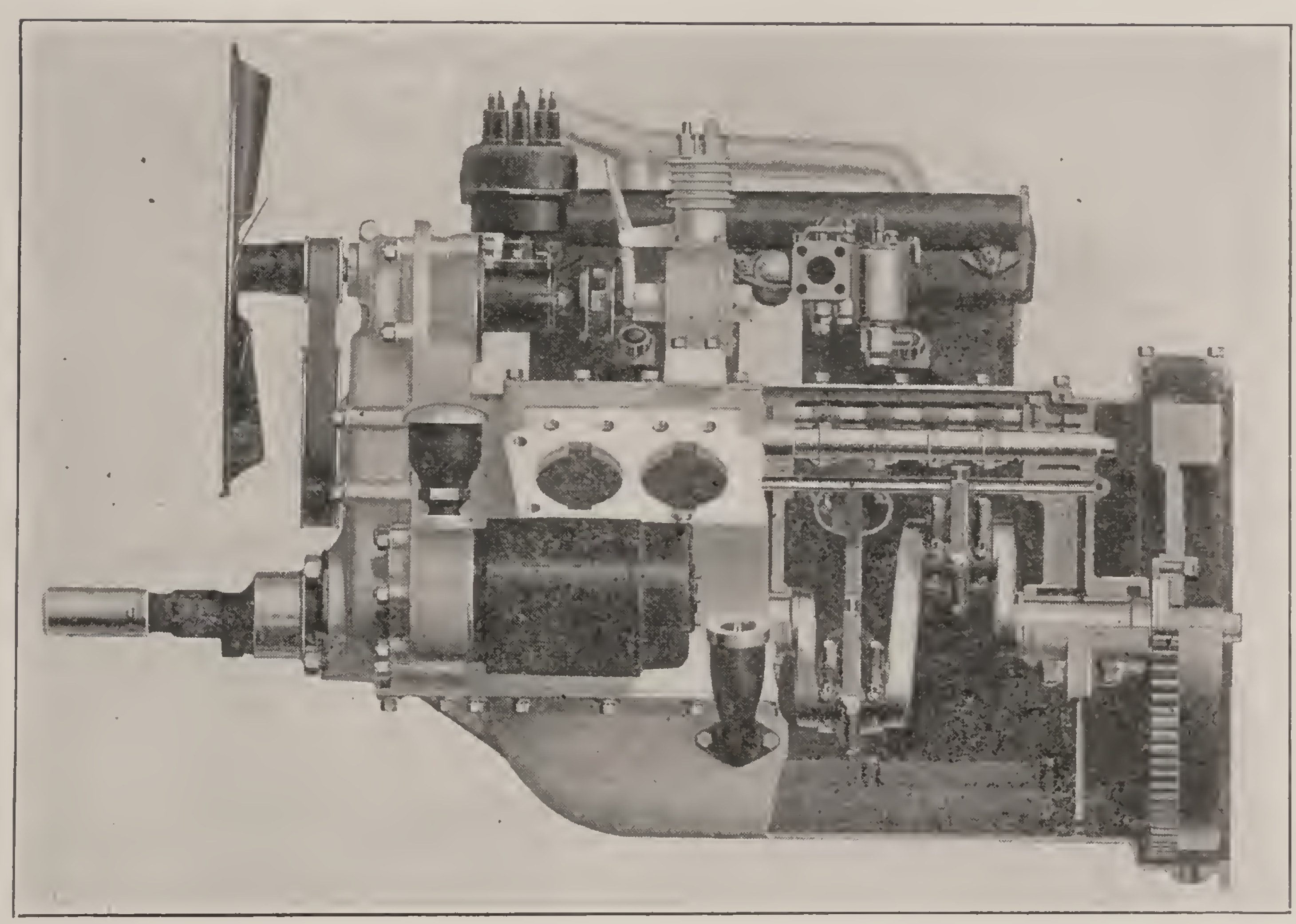
YOKE-END RODS USED

The crankshaft is a simple three-bearing type with the throws all in one plane; in fact, it is in the crankshaft that an eight of the V-type has a distinct advantage over a six. By coupling two connecting-rods to each throw bearing, it is possible to use a shaft exactly similar in form to that required for a four. In order to fasten the connecting-rods of each opposing pair of cylinders to the same bearing, one rod has a yoke end, and the other rod is made with a small end which goes between the arms of the yoke. Each of these arms is provided with its cap to go around the bushing. Pins fasten the rod to the bushing so that it oscillates with the rod on the shaft bearing. The small-end connecting-rod is free to move on the bushing, its bearing therefore being the outer surface of that portion of the bushing between the arms of the yoke. Both the main bearings and the connecting-rod bearings are babbitt-lined bronze. All have a diameter of 1 11-16 inch with the following lengths: front main, 3 inches; center main, 1 3-4 inch; rear main, 4 inches; connecting-rods, 2 3-4 inches.

ACCESS TO CAMSHAFT

The camshaft is mounted on three bearings vertically above the crankshaft. Its bearings are in the crankcase, and a plate bolting to the top of the crankcase between the two cylinder blocks gives access to the cam assembly. Like the crankshaft, the camshaft is the same type as would be used in a four-cylinder motor, having eight cams, each of which operates two opposite inlet valves or two exhausts. Pivoted to the crankcase are small rocker arms which go between the valve tappets and the cams. These are necessary so that the valve lift will be straight upward on the valves, the rockers through their small rollers bearing against the cams, taking the side thrust. The front camshaft bearing is phosphor bronze, measuring 1 inch diameter by 3¾ inches length. The center and rear bearings are of babbitt and their dimensions are respectively 1 11-16 by 1¾ inch, and 1 by 2½ inches.

Valves are conventional bevel-seated types, 1⅜ inches diameter and 15-32 inch lift. With a motor of this kind where each cam does double duty in operating two valves, there is only one practicable



Part sectional view of King eight-cylinder motor. The two rear cylinders on the left side have been cut away entirely to show the camshaft in the center of the engine, and also the crankshaft and connecting-rods of the corresponding cylinders on the right. The two front cylinders are removed to show the mounting of the ignition distributor, the carburetor, etc., between the cylinder blocks.

timing, in which the inlets open at top dead center and close 45 degrees past bottom dead center, and the exhausts open 45 degrees before bottom center and close at top center. Intake and exhaust valves are interchangeable.

The camshaft is driven by a Link-Belt silent chain which in addition to working over sprockets on camshaft and crankshaft is carried over a small third sprocket to the right of the two main ones. This serves two purposes: first, for driving the pressure oil pump, and second, to give a means of adjusting the chain. The latter is accomplished by moving the small sprocket slightly to the right so as to increase the distance from the centers of this sprocket and the two main sprockets.

Back of the sprocket driving the camshaft and oil pump, the crankshaft carries another sprocket over which another chain runs to the left to the generator sprocket. The position of the generator may also be shifted slightly to take care of wear on this chain. On the camshaft and back of its sprocket there is a spiral gear meshing with a smaller gear which drives the ignition distributor shaft that is directly in line above both camshaft and crankshaft. As the distributor proper is vertical, a worm-and-gear mechanism transmits the horizontal drive into vertical. On the end of the horizontal drive-shaft is a dog clutch which may be shifted to engage the single-cylinder tire pump on the top plate of the crankcase between the cylinder blocks. Chains and distributor driving gears are all completely housed by an aluminum plate, and they run in oil.

The carburetor is a specially designed type having two openings, one connecting directly to the straight horizontal intake tube running to the single opening in each cylinder block. Distribution to the several ports is effected within the casting. The carburetor is fitted with a hot-air pipe, and gets its fuel from a tank carried at the rear of the chassis.

THE FIRING ORDER

The ignition distributor takes its current from the storage battery, and has hand and automatic control. In firing, the order alternates from one side of the engine to the other so that impulses will balance and an even turning effort result. Calling the first cylinder on the right No. 1, the second on the right No. 2, and so on, and considering the first on the left as No. 5, the firing order is 1, 8, 3, 6, 4, 5, 2, 7.

The motor is lubricated by pressure feed by means of the chain-driven pump which is of the gear type and lifts oil from the oil base up through a horizontal supply tube lying along the inside of the crankcase, this delivering oil directly to each of the three main crankshaft bearings, from which it is forced through the holes drilled in the crankarms to the connecting-rod bearings. The center main bearing in this way delivers oil to rod bearings Nos. 2 and 3, while the front cares for No. 1 and the rear for No. 4. The oil thrown off by the crank bearings lubricates the cylinders and the camshaft bearings.

Thermo-syphon cooling is used. There are separate outlets and inlets from each cylinder block to the cellular radiator, which is aided in its work by a 16-inch fan. Free circulation is furthered by the ⅝ inch water space in the jackets. The absence of water pumps is a factor in securing simplicity.

The electric cranking and lighting system, of Ward Leonard make, is a 6-volt two-unit type with the generator attached to the outer left side of the crankcase and driven at twice crankshaft speed by a silent chain. The cranking unit is on the right side of the crankcase next to the flywheel to which it connects in the usual way. There is no intermediate gear, the starter pinion meshing directly with the flywheel teeth. The ratio is 10.5 to 1; that is, the electric motor runs at ten and one-half times the velocity of the crankshaft.

In connection with the system a Willard 80 ampere-hour battery is placed under the right front seat, where it is readily accessible. The system operates on 6 volts.

Nothing new to King design appears in the chassis and drive system. Clutch and gearset are in unit with the motor, a bell-housing bolting to the flywheel housing by flange construction inclosing the mechanism compactly. The clutch, a multiple-disc type running in oil, has bronze plates against cork-inserted steel ones. The gearset is a conventional three-speed, selective type with its shaft carried on roller bearings. It has center control levers.

FLOATING AXLE DETAILS

The drive shaft is fitted with a universal at its front end, and back of it centers a compactly designed torsion tube which is in unit with the pressed steel housing of the floating axle. This has a large cover plate at the rear to give access to the differential and driving gears. Ball bearings are used throughout the axle.

The braking system is of the usual external contracting service and internal expanding emergency type acting on rear drums, which are 14 inches in diameter by 2 inches wide. The brake operating rods are a part of the axle unit.

In this new car, the cantilever form of rear springs is still adhered to, the King company having used them since it brought out its first car some years ago. They have a trunnion mounting to the frame rail a little forward of the center of length, shackle at the rear to the axle housing, and at the front to the frame.

The frame is a bottle-neck design which is light and strong. Three cross-members in addition to the bracing given by the motor make it rigid. There is a slight kick-up at the rear to clear the axle.

GENERAL ELECTRIC.

For our purposes, Electricity is a form of force which can be conducted through wires, the same as water under pressure can be conducted through pipes.

This force, Electricity, when conducted through wires wound around iron and steel parts, makes electro-magnets of these parts, and these electro-magnets, of course, are capable of doing work. These electro-magnets will either pull towards them or push from them, other iron or steel parts, depending on the connections the machine provides for and by this attraction and repulsion, rotating or reciprocating movement can be obtained.

Therefore, in general, all electric motors and generators are alike. They are in reality only electro-magnets attracting or repelling pieces of iron and steel, which, for the purpose of proper connections, have windings thereon, brushes bearing on a disc, or commutator, connected to these windings, to carry the electric current TO or FROM these windings.

If electric current is carried TO the windings, it must come from some source of supply; in this case an electric storage battery; and the device utilizing this electric current immediately become an ELECTRIC MOTOR, because, by the supply of electric current to the windings, the magnetic force which is developed acts on the other magnetic parts of the machine in such a way that this part, the armature, will rotate with sufficient torque, or twisting force, and speed, to crank an automobile engine for instance. It may be necessary to increase this power by putting gearing between the motor and the crank shaft, but that is merely a mechanical detail.

Thus electrical energy is converted to mechanical energy, or work.

On the other hand, electric current may be carried FROM the windings, because the process described above is reversible. In other words, mechanical energy can be converted to electrical energy.

These same iron and steel parts with the windings around them, which comprise electro-magnets in close proximity to each other, will, if moved across each other by external power, induce electric currents in the windings, these currents being lead away through the commutator and brushes. This method of producing or generating, electric currents is alike in all generators.

A practical understanding of electricity is best obtained by considering it as a form of energy, and to look upon a circuit as a means for transmitting this energy from one point to another. To make this point clearly understood, several mechanical comparisons will be given.

In the first case, suppose two pulleys are placed a short distance apart, and it is desired to drive one from the other. (See Fig. 1.) The usual way of accomplishing this is to place a belt upon the two pulleys. Then when the pulley "A" is caused to rotate, the pulley "B" will be driven by the belt as it passes from A to B on one side and returns on the other.

Another illustration is that of a system in which water is the medium utilized to transmit the energy from one point to another. (See Fig. 2.) "A" is a rotating pump, C and D, the pipes, and B, a water motor. This whole system is filled with water. When the pump A is caused to rotate, water will be forced through the pipe C, through the water motor B, causing it to rotate, and return to the pump through the pipe D. In this case the water serves the same purpose as the belt in the first illustration, and by its circulation or flow, carries the power from the pump to the water motor.

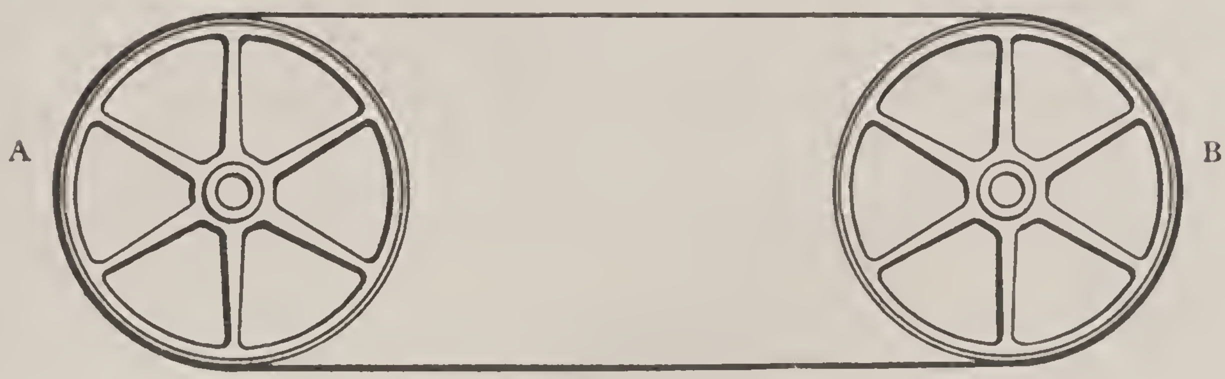


Fig. 1.

Figure 3 illustrates a method of transmitting energy electrically. A represents a generating machine, C and D the wires, and B the electric motor. When the generator is caused to rotate, it causes a current of electricity to flow from the generator, through the wire C, through the motor B and return to the generator through the wire D. In this case the electric current acts the same as the belt and the water in the two former illustrations, transmitting the energy from the generator to the motor.

In each of the above cases, the energy transmitted must be supplied from some outside source, such as a steam or gas engine. In

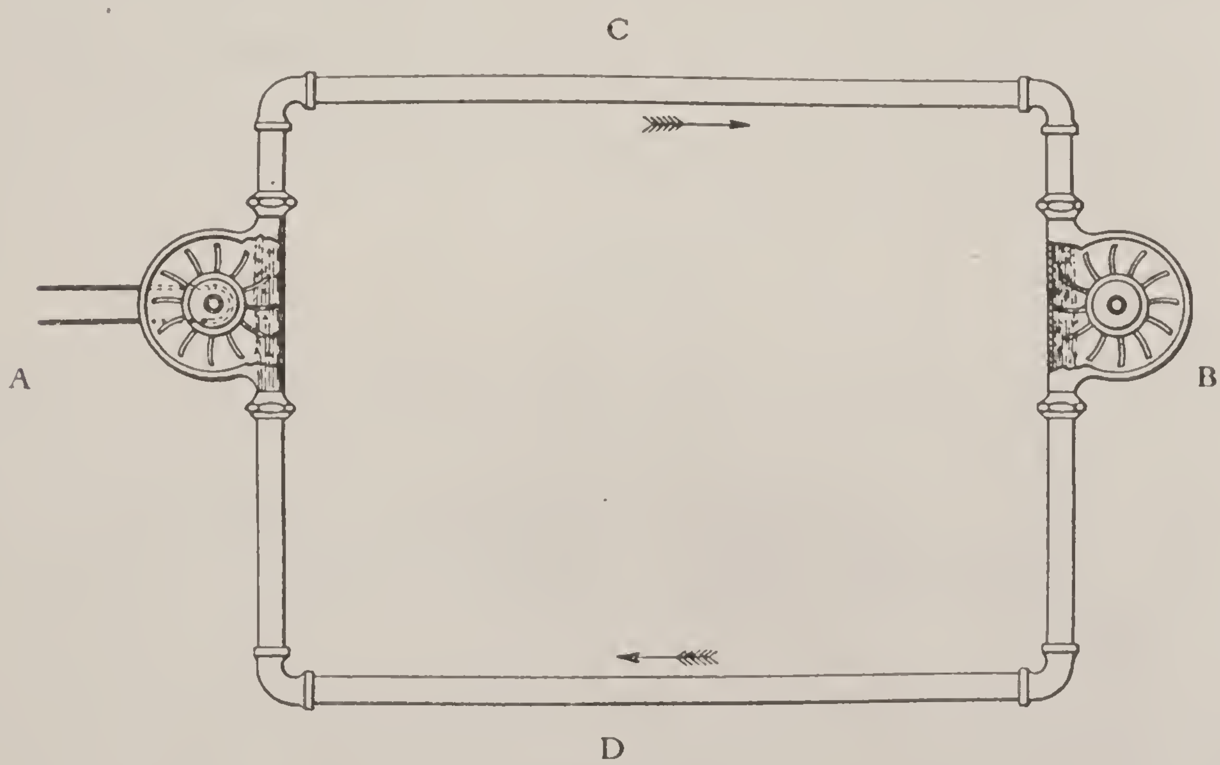


Fig. 2

other words, an electric current may be considered as a flexible belt capable of carrying power from one point to another.

It will be noticed that a close relation exists between the methods of transmitting power by water and electricity. The pump corresponds to the generator, the pipes to the wires, the water motor to the electric motor, and the water to the electricity. Therefore, if the relations governing the transmission of energy by means of water are understood, it will be easy to understand the relations which exist in the electric system.

In Fig. 2 the pipe through which the water flows from the pump may be considered as the positive pipe, while the return pipe may be considered as the negative pipe. The same may be said of the wires connecting the generator and the motor in Fig. 3. The terms positive and negative do not mean that the respective wires carry different kinds of electricity or water, but only indicate the direction of flow. The positive wire is considered as the path of the current from the generator and the negative wire is the path of the current returning to the generator.

In mechanics there are two ways of transmitting power from one point to another. First, where the parts of the machine travel

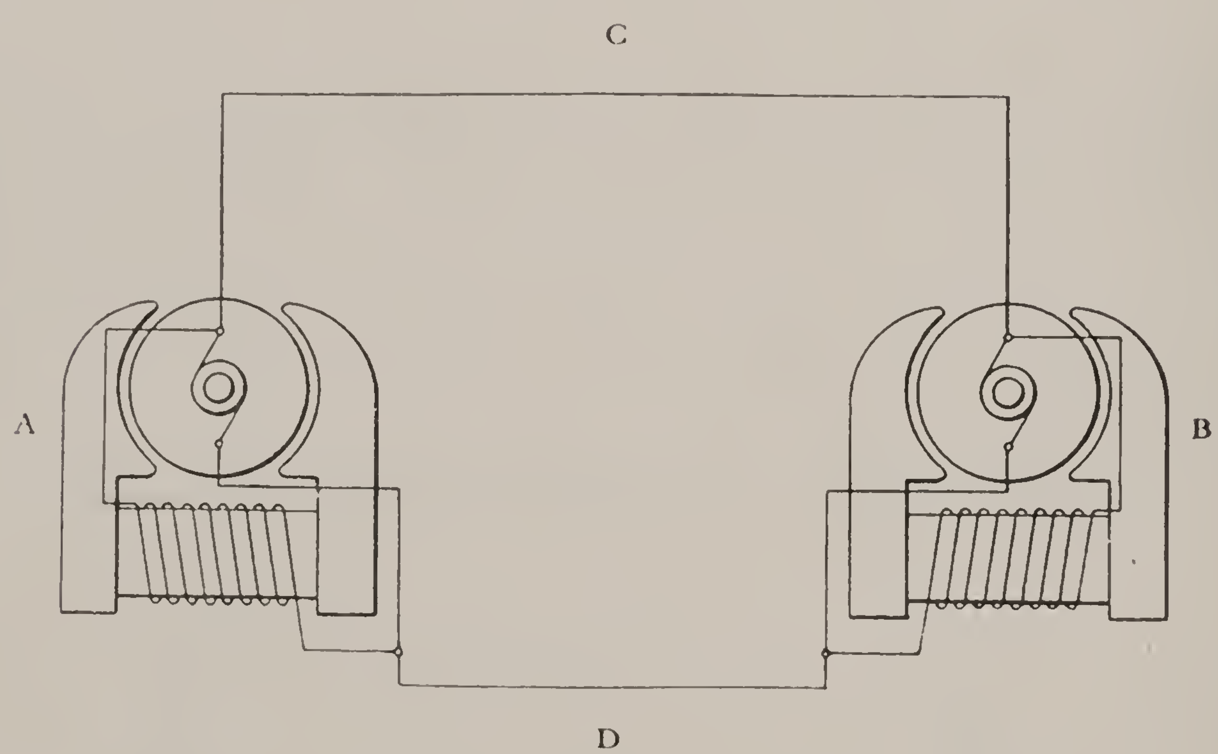


Fig. 3

continuously in one direction, as a belt or train of gears, and, second, where the parts have a reciprocating or backward and forward movement, as the piston of a steam engine and its connecting rod. Likewise, there are two ways of transmitting power electrically: First, where the current flows continuously in one direction, and, second, where the current moves back and forth. The first is called direct current, while the second is called alternating current.

To make this explanation better understood, reference is made to Figs. 4 and 5.

Fig. 4 is a reproduction of Fig. 2, and shows the method of transmitting power by means of a continuous or direct flow of water. In Fig. 5, A represents a reciprocating pump which is connected by the pipe B to the cylinder C in which is mounted a piston similar to the one in the pump A. If the system is filled with water it is obvious that if the piston in the pump A is caused to move back and forth, a similar movement will be imparted to the piston in the cylinder

C through the medium of the water in the pipe B. This is transmitting power by means of an alternating current of water.

In Fig 5 if the piston in the cylinder A is started at the extreme end of the cylinder, and the crank D to which it is connected is made to rotate one complete revolution, the water will flow first in one

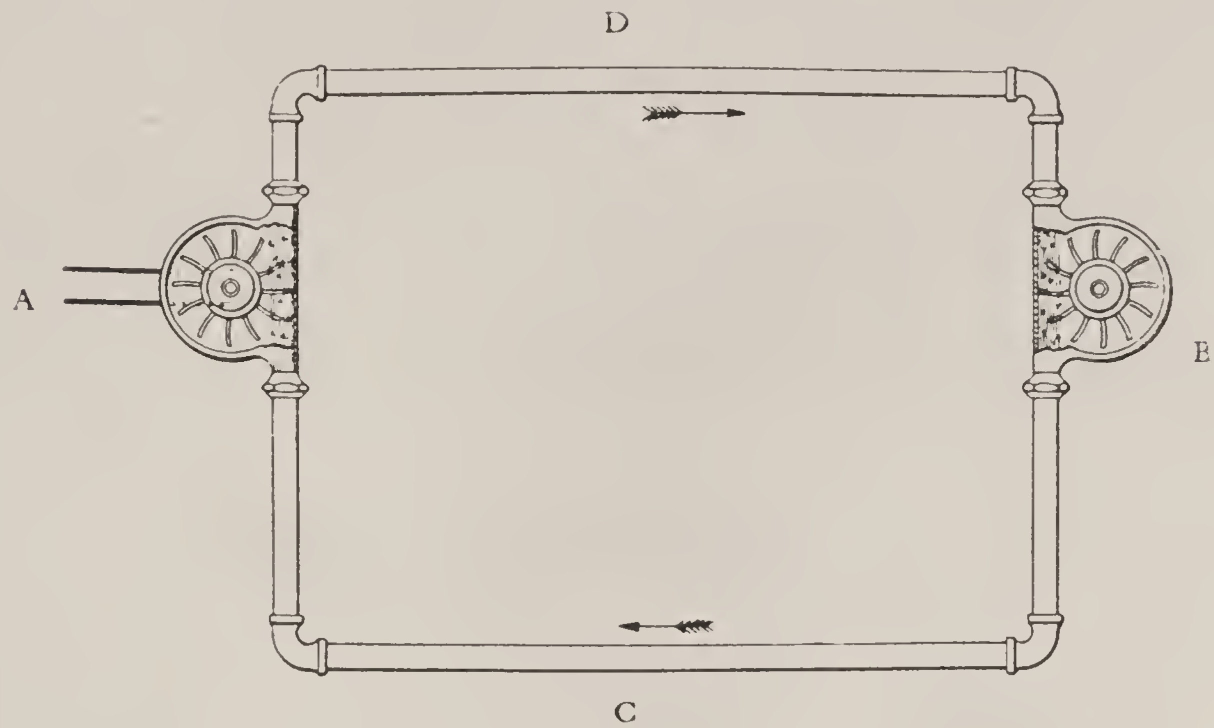


Fig. 4

direction and then in the other, during each half revolution of the crank. This movement of the water first in one direction and then in another, is called a cycle, while the movement in one direction, or that caused by a half revolution of the crank, is called a half cycle or an alteration. In this case a cycle is two alterations.

In the commercial transmission of power by means of electricity there are several numbers of cycles in use. These are reckoned in so many cycles per second, as for example, we speak of 30-cycle or 60-cycle current, this means 30 or 60 cycles per second. This is known

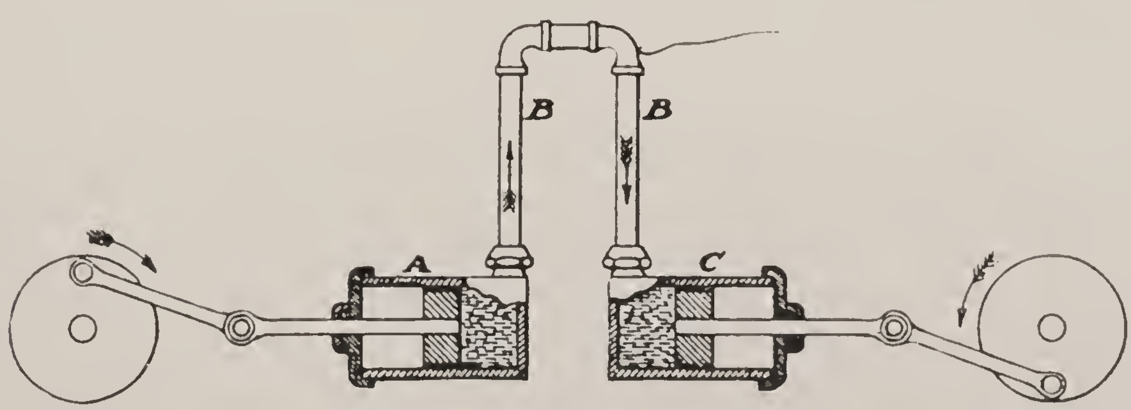


Fig. 5

as the frequency of the current. In some cases the frequency is specified as so many alterations per minute. As shown above, a cycle is equivalent to two alterations; therefore, 60 cycles per second would represent 120 alterations per second, or 7,200 alterations per minute.

It has been the purpose of the foregoing statements to make clear the following points:

1. That electricity is not power in itself.

2. That it acts only as a means for transmitting power, in the same manner as a belt, transmitting power from one point to another.

For instance, the power necessary to drive a street car is furnished by the boilers and the engine at the power house, and the act of turning the current on in the car is just the same as gripping the car fast to the cable in the old-fashioned cable system. In either case the engine does not pull the car until it is coupled to it. In the cable system the power is transmitted through the town by means of a steel cable running underground over suitable pulleys, while in the electric system, the power is transmitted through the town by means of an electric current flowing through the wires.

Two things govern the amount of power which can be transmitted by the water system of Fig. 2; First, the pressure with which the water is forced through the pipes, and, second, the size of the nozzle at the motor. The size of the nozzle governs nothing more than the amount of water which will flow through this hole in a given

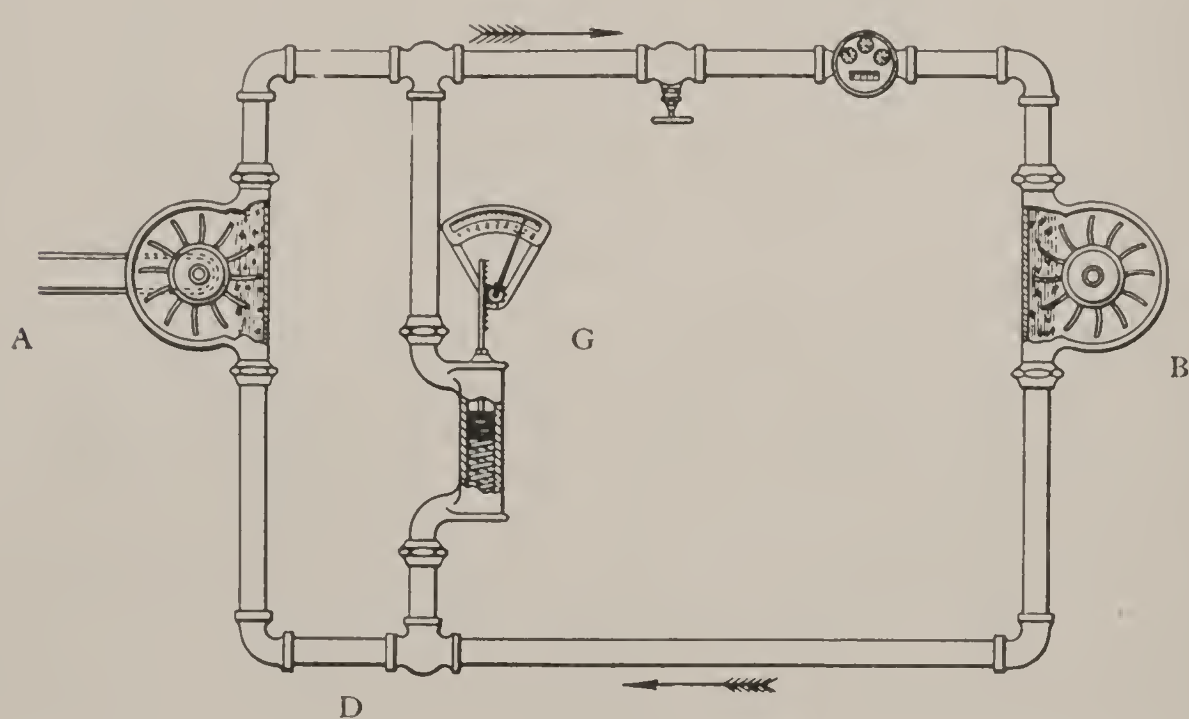


Fig. 6

time; the smaller the hole, the less would be the amount of water which would flow through. In other words, the two things which govern the amount of power transmitted by this water system are, first, the pressure, and, second, the amount of water which flows.

This principle is used in figuring the amount of power which can be obtained from a water fall. If the water fall is not very high, a large quantity of water would be required to furnish a given amount of power; if, on the other hand, the fall is extremely high, the same amount of power could be obtained from a small amount of water, because the pressure or head, as it is termed, would be much greater in the second case than in the first. To transmit the same amount of power, if the pressure is increased, then the amount of water flowing must be decreased, and vice versa.

To make the above clear, Fig. 6 is given, in which A represents a pump, and B a motor. At G is shown what might be called a pressure meter, which is connected to C and D. The meter consists of a cylinder with a piston; behind this piston is a spring. When the pump is standing still, the pointer of the meter would stand at zero. If the pump is turned, it will cause the pressure in the pipe C to rise. This would press down the piston of the meter G and move the hand over the dial, thus indicating the difference in pressure between the two pipes. This pressure does not indicate the amount of power, as the valve at E may be closed. If the valve is opened, and the water is allowed to flow through, the motor will turn. At F is placed a meter like the ordinary house meter, and measures the amount of water which flows through the pipe.

In this way the amount of power which is transmitted by this system can be determined. Both the pressure and the amount of water flowing must be known. Suppose the water motor is used to drive a small fan and it requires a pressure of 10 pounds, as indicated on the meter G, and a gallon of water per second flowing through the

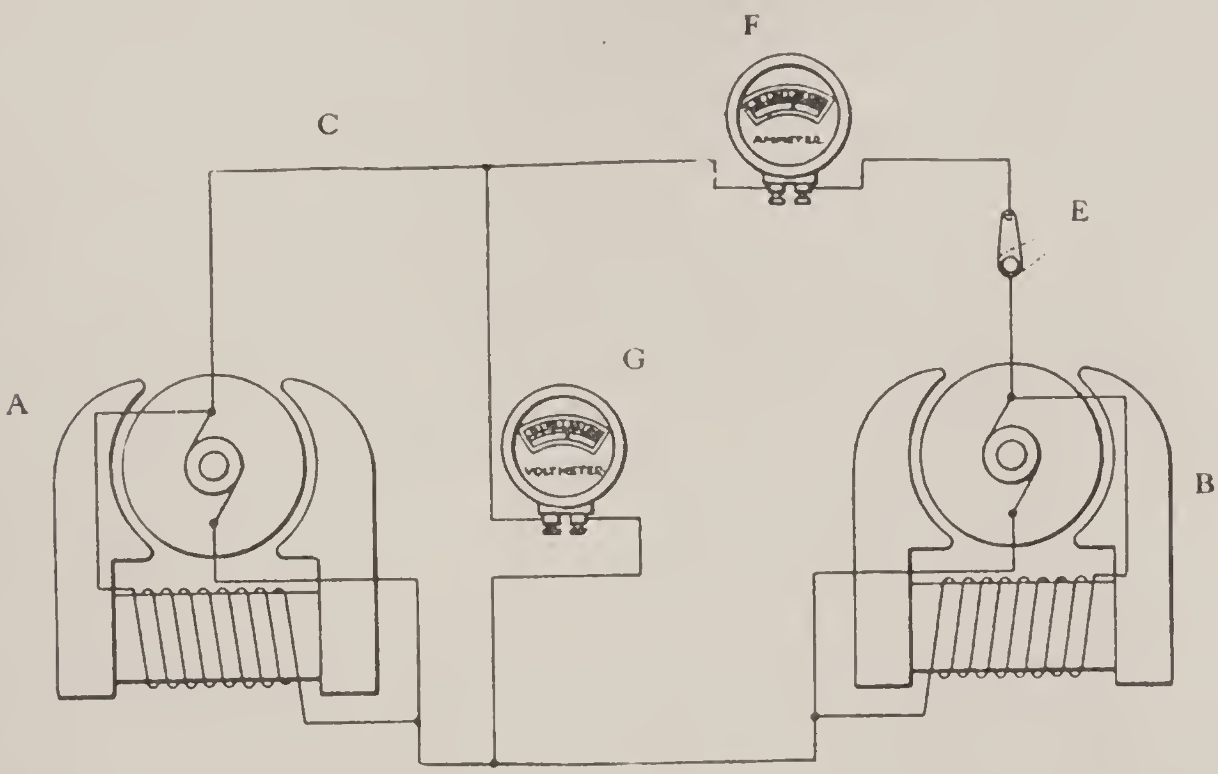


Fig. 7

meter H. Now, if the pressure be raised to 20 pounds, a smaller nozzle can be used on the water motor; in this case, the pressure has been doubled and therefore the quantity of water which is needed to run the motor would be only one-half as much. The meter H would show only one-half the number of gallons per minute. If, however, the pressure was reduced to 5 pounds, the amount of water flowing through the motor would have to be increased to double that which is required for 10 pounds pressure.

In Fig. 7 is given an illustration of an electrical system of transmitting power. This system consists of a generator, a motor and two meters, the functions of which will be explained hereinafter. The amount of power which is transmitted in the water system depends, first, on the pressure, and, second, on the rate at which the water is flowing. Now the same two things govern the amount of power transmitted by electricity—that is, first, the electric pressure which is driving the current through the circuit, and, second, the rate at which the current is flowing. At G is a meter corresponding to the pressure gauge in the water system. If the circuit at E was open, and the generator turned, this pressure meter would show the difference in the electrical pressure between the two pipes. The motor will not run, however, until the switch is closed, but just as soon as this is done, the current will begin to flow and thus operate the motor. In our water system, the rate of flow was measured with a meter at F In the electrical system (Fig. 7), the rate at which the current is flowing is measured by a similar electric meter at F.

The pressure between the electric wires is measured in volts. A volt is nothing more than the unit of electric pressure. The rate at which the water flowed in the water system was measured in gallons, while the rate at which the electricity flows in the electrical system is measured in amperes. Therefore, an ampere is the unit indicating the rate at which the current is flowing.

The things that are true in the water system, are true in electricity. That is, if the voltage or electrical pressure is increased, the current can be decreased to furnish a given amount of power. To illustrate. If a motor delivering 5 horsepower requires 40 amperes at 100 volts, then to furnish the same amount of power at 200 volts would require only 20 amperes, but if the voltage were dropped to 50, then it would require 80 amperes. The advantage of using as high a voltage as possible can be readily understood. When a high voltage is used, a corresponding smaller amount of current is needed, and consequently, smaller wires can be used. If we were transmitting power for 10 miles, it would be advantageous to make the wires small because the cost of copper wires is quite considerable. Now, if by increasing the voltage of the system, we can reduce the amount of copper to one-half or one-fourth that of a lower voltage system, the advantage can at once be seen.

In the foregoing chapter the following points have been explained:

1. That pressure and the rate at which the water and the current flow are the two things which govern the transmission of power by water and by electricity.

2. That pressure in the water system is measured in pounds and in electricity is measured in volts.

3. That the rate of flow in the water system is measured in gallons per second, and in electricity is measured in amperes.

4. That the same laws which govern the transmission of power by water, govern the transmission of power by electricity.

5. If we increase the voltage of a system, we can decrease the current required in the same proportion.

It has been explained that the two important elements which enter into the transmission of power by water and electricity are pressure and the rate of flow. The same thing is true in the transmission of power by mechanical means, only in place of the words "pressure" and the "rate of flow," the words "force" and "rate of movement" are used. When the pressure on the water pipe forced the water or moved the water through the nozzle, work was being done, because the water motor was turning. Whenever a force moves something, work is done, but as long as force is not moving anything, no work is done. To illustrate this, suppose a weight of ten pounds is placed on a table. The weight would exert a force of ten pounds upon the table yet it could not move, and, therefore, no work could be done. If this weight is attached to the string of a clock it will move down slowly and in so doing drive the mechanism of the clock. It will give out as much work in moving down to the floor as was stored up in it when it was placed on the table. In this case, the weight acts as a storage for work. When we wind the weight of a clock, we simply store up the energy in the weights. The power to run the clock is furnished by the person who winds it.

Now how is this power measured? In measuring anything, it is always necessary to have a unit. In measuring lengths, the foot is the unit; in measuring weights, the pound is the unit. A piece is so many feet long, or an article weighs so many pounds. In measuring power, the unit is the amount of work done in raising a weight of one pound one foot, and is called a foot-pound. Suppose a weight of 10 pounds was raised 3 feet. How much work would be done? If 10 pounds had been raised one foot, we would have done 10 foot-pounds of work, and in raising it three feet, 3 times 10, or 30 foot-pounds of work would have been done. All that is necessary to get the amount of work done is to multiply the weight of force, expressed in pounds, by the distance moved, expressed in feet.

There is a distinction between the words "WORK" and "POWER." The word "work" means that a certain weight or force has been moved a certain distance; that is, 1,000 pounds moved 10 feet would be 10,000 foot-pounds. The word "power" means that a certain amount of work has been done in a given time. In other words, power means how fast, or the rate at which work is done! that is, if 1,000 pounds are raised 10 feet in two seconds, just twice as much power would be required if it was raised in one second, because the work is done just twice as fast.

The meaning of the word horsepower can now be explained. A horsepower is the doing of 550 foot-pounds of work in a second; that is, if a weight of 550 pounds is raised one foot in a second, it represents a horsepower; of, if a weight of one pound be raised 550 feet in a second, it represents a horsepower; in other words, whenever the weight raised multiplied by the distance moved is equal to 550, and this work is done in a second, it requires a horsepower to do it. Suppose a weight of 1,100 pounds is raised 10 feet in a second; how many horsepower are required? Now, 1,100 multiplied by 10 equal 11,000 foot-pounds of work, and this is done in a second. How many horsepower does this represent? A horsepower is 550 foot-pounds of work per second, and 11,000 foot-pounds would be equal to 11,000 divided by 550, or 20 horsepower. If this had been done in two seconds, only one-half the number of foot-pounds would have been done per second, or 5,500, and this divided by 550 is equal to 10 horsepower. This conclusion can then be drawn—the faster the work is done the more horsepower is required.

It was shown that the force multiplied by the rate at which it moves, is power. The same thing is true in electricity; force in volts multiplied by the rate of flow in amperes, is equal to power. Suppose in Fig. 5, our volt-meter shows 100 volts and the ammeter shows 10 amperes. These two multiplied together would be 100 times 10, or

1,000. It can be called volt-ampers just as our other is called foot-pounds, but we have another name for it, which is "watts." This word-unit you will recognize, being named after James Watt, the inventor of the steam engine.

There is another term which is used very much, and that is "kilowatt," which is 1,000 watts. Kilo means thousand; therefore, if we say two kilowatts, we mean two thousand watts.

The relation between watts and horsepower is this: 746 watts are equal to one horsepower. For all practical purposes, a horsepower equals 750 watts; then 1,000 watts, or a kilowatt, equals one and one-third horsepower, and a horsepower is three-fourths of a kilowatt.

In buying power from the Electric Light Company, there are two things which regulate the cost: First, the amount of power required; and, second, the length of time that it is used. The conditions of buying electric power are very similar to that of hiring a horse from a livery stable. If a horse is used for an hour, the cost will not be as great as if used all day.

The unit of measuring power in mechanics is what is known as horsepower-hour; in electricity, it is the kilowatt-hour. The kilowatt-hour is the consumption of one kilowatt of power for one hour's time. This is equivalent to 1 1-3 horsepower-hour, as it has been explained that a kilowatt is equal to 1 1-3 horsepower. The rate which is given by electric light companies is based on the kilowatt-hour. If the rate is 10 cents, that means 10 cents for a kilowatt-hour. A simple problem will make this clear. How much will it cost to run a motor furnishing 8 horsepower for 10 hours? The first thing to determine is how many kilowatts 8-horsepower represents. As explained before, a horsepower is equal to three-fourths of a kilowatt; therefore, 8-horsepower represents 6 kilowatts. If the 6 kilowatts were to be used for 10 hours, then we would have 6 times 10, or 60 kilowatt-hours. If the rate was 10 cents per kilowatt-hour, then the cost would be 60 times 10, or $6.00.

In incandescent electric lighting, a 16-candlepower lamp consumes about 50 watts. How many lamps would it require to consume a kilowatt? If one lamp consumes 50 watts, to consume a kilowatt would require 1,000 divided by 50, or 20. Then 20 16-candlepower lamps require a kilowatt of power. Now, if these lamps were burned for one hour, they would consume one kilowatt-hour, and if the rate was 10 cents, it would cost 10 cents to burn 20 lamps for one hour; in other words, it would cost about ½ cent to light one 16-candlepower lamp for one hour. Turning on the 20 lamps means that the engine at the power house must furnish 1 1-3 horsepower more, which means in turn that more fuel will be required to furnish the steam to drive the engine.

The most interesting part of electrical work is converting the power transmitted by an electric current into mechanical motion so that it may be used to drive street cars, run shops and do various other kinds of work. There are several methods in which electric power is used; first, for its heating effect; second, for producing mechanical motion, and third, for chemical work. The heating effect is used for lighting common incandescent lamps. An incandescent lamp consists of a thin carbon filament enclosed in a bulb from which the air has been exhausted. When the current flows through this filament it is made white hot. In the ordinary arc lamp, the current passes across a gap between two carbon rods. This air gap offers a resistance to the current and causes the ends of the carbon rods to become intensely hot. The heating value is also utilized in cooking, baking and electric furnaces.

The chemical method of using electrical power is plating, refining copper, etc.

The most common way of using electricity, however, is to produce mechanical motion. This will now be explained. If an insulated wire is coiled around a bar of iron and then a current of electricity passed through this coil, something strange occurs. The bar will pick up small particles of iron or steel as long as the current is going through the coil. This power to attract small particles of iron or steel is called magnetism. If this rod is one of soft iron, it will lose

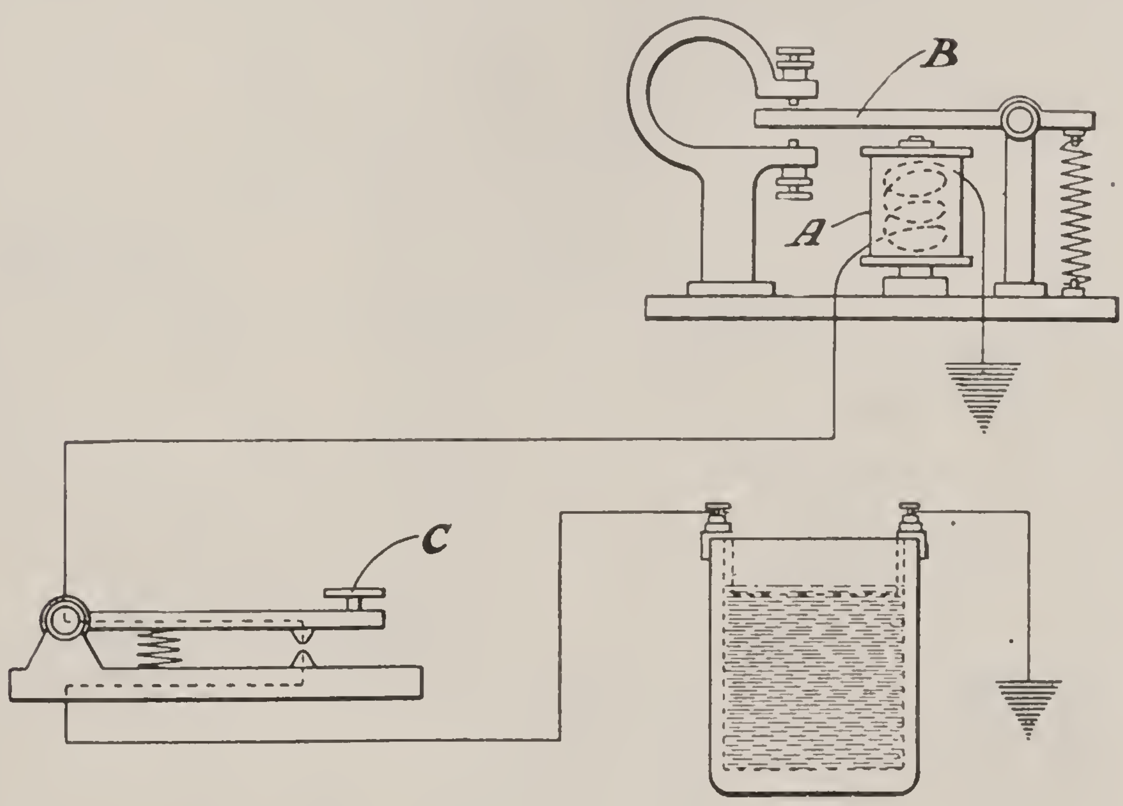


Fig. 11

its magnetism as soon as the current is cut off, but if made of hardened steel, will retain its magnetism and be what is called a permanent magnet. A permanent magnet when supported in the center either by a pivot or a string, will turn so that one end points North and the other South. The end which points North is called the north pole, and the end which points South, the south pole.

This is the construction of an ordinary compass. If another magnet is brought up close to the suspended one, the following interesting things will be noticed: When the north pole of this magnet is brought up close to the north pole of the suspended one, the suspended magnet will immediately rotate away; but if you present the north pole of this magnet to the south pole of the suspended one, the latter will immediately rotate toward it. If the operation is reversed, and the south pole of this magnet presented to the south pole of the suspended one, they will be driven apart, while if you present the south pole to the north pole, they will be pulled together.

The fundamental laws of magnetism are: First, that magnets have two poles; one is called the north and other the south pole, because the north pole points toward the north, and the south pole toward the south, when the magnet is free to turn. Second, that two unlike poles attract each other, and two like poles repel.

To show this attraction and repulsion of unlike and like poles, put a piece of paper over a pair of magnets and sprinkle iron filings over the paper. The two like poles will be brought together. In the first case, the iron filings present the appearance of two jets of water being forced against each other, and in the second case of a bunch of strings or cords connecting the ends of the two magnets.

To illustrate some simple ways in which the principle of magnetism is utilized, the following examples are given: First, the telegraph; this is illustrated in Figure 11 and shows a simple telegraphic circuit. It consists of a magnet at A over which is placed an armature B. When the key at C is pressed it allows the current to flow

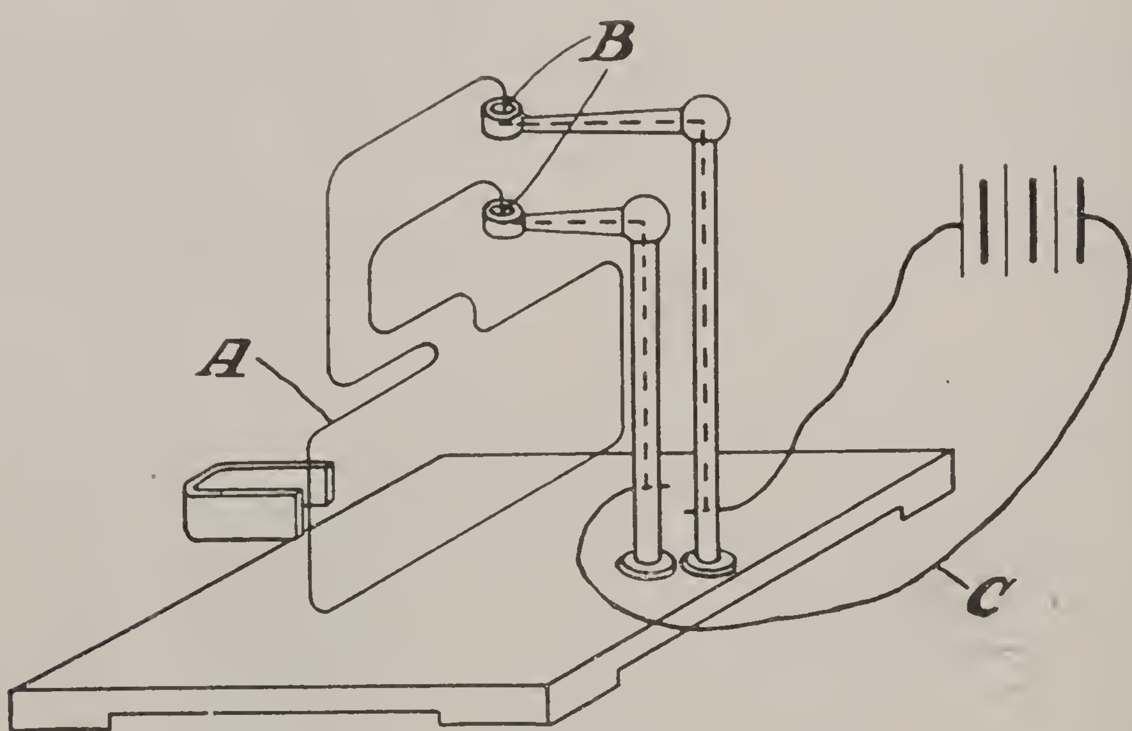


Fig. 14

from the battery around in the direction indicated by the arrows. This will cause the iron cores in the magnet coils to be magnetized and draw down the armature. Upon releasing the key, the current will stop flowing and the magnet lose its power. This will release the armature and the spring will pull it away. If the key is placed many miles away from the sounder, the operation is just the same.

A very important relation exists between a wire carrying a current of electricity and a magnetic field. Fig. 14 shows a device which best illustrates this relation.

The loop of wire A is so suspended as to rotate about the center B and is connected by means of its supports to a source of electric current as the battery C. If a magnet is placed near one side of the loop while the current is passing, the loop will be set in motion about its center B, either toward or away from the magnet, depending upon the direction of flow of the current.

This illustrates in its simplest form the principle of the electric motor. If the conditions are reversed and the wire loop is me-

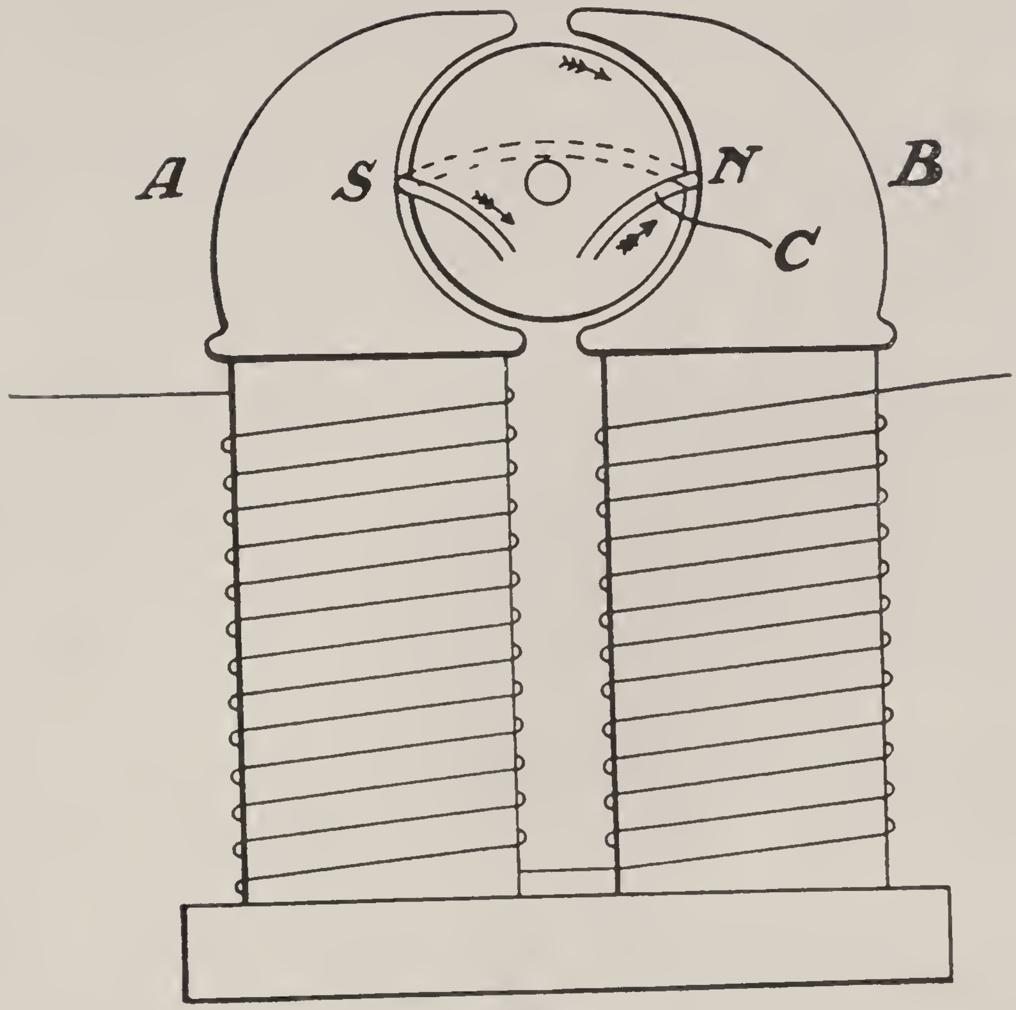


Fig. 15

12

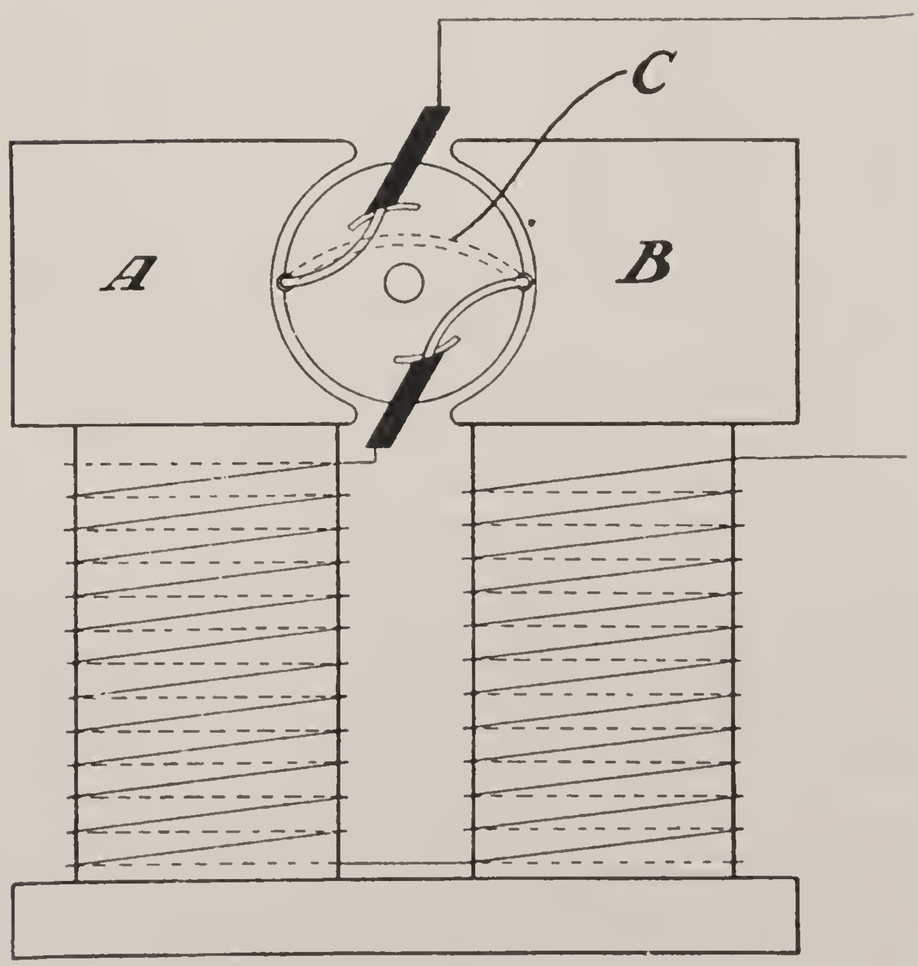


Fig. 16

chanically caused to move through the field of the magnet. a current would be generated in the wire, which is the principle of the generator.

Fig. 15 shows an electric motor in which the above principle is applied. Instead of a permanent magnet the frame of the machine is so formed that wire may be wound upon it and thus, by the introduction of a current, the points A and B become the poles of the electro-magnet.

The loop of wire is shown at C. If now a current is passed through the coils about the magnet and through the loop C, the latter will be caused to rotate about its axis.

In practice, instead of a single loop, as many loops as may be placed on a core of given diameter are wound, the ends being connected to segments of metal, which are mounted upon the armature shaft and insulated from each other.

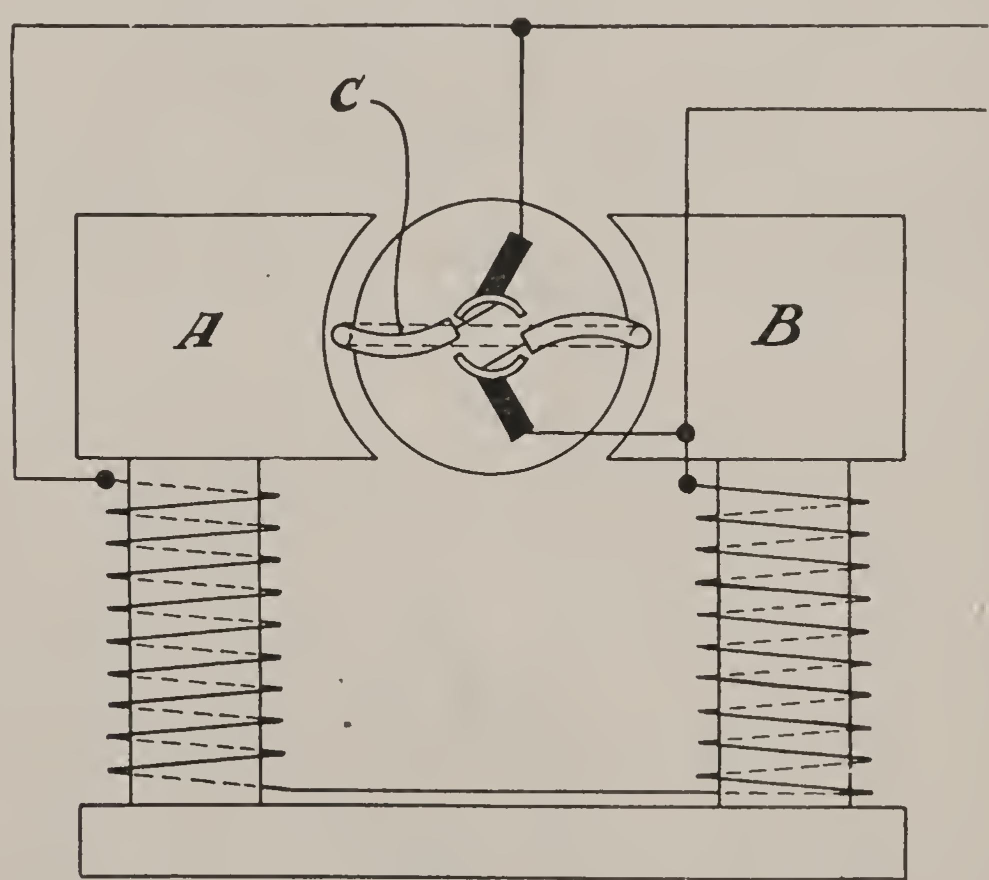


Fig. 17

Brushes are so arranged that they will rest upon two opposite segments (See Fig. 16), which are connected to opposite ends of a complete loop of wire on the armature. These brushes serve to connect the successive loops to the stationary windings, while the rotating part or armature is in motion.

The connection of successive loops of wire during the rotation of the armature produces a continuous pull, for as fast as one passes off the brush connections another takes its place and the current is automatically shifted from one coil to the next in order.

A motor connected as shown in Fig. 16 where the current passes first through the armature is known as a series motor, but if the current is divided, part of it through the field and part through the armature, it is known as a shunt motor. Such connections are shown in Fig. 17.

The shunt winding permits of more regulation of the currents passing through the machine; that is, the amount of current passing through either the field coils or the armature may be changed without affecting the other. This enables one to control the speed of a motor very accurately and in the case of a generator the amount of current generated may be controlled within narrow margins.

THE THEORY OF THE STORAGE BATTERY

Probably no other piece of electrical apparatus in common use today is so generally misunderstood as the storage battery. The following description will give the reader a clear conception of the elementary principles involved in the operation of the storage battery.

In EFFECT, the storage battery has the same relation to an electrical system that a standpipe or reservoir has to a water supply system; but note the difference in the MEANS which lead to this EFFECT. Water is stored in the reservoir merely as water. Electricity cannot be stored as electricity. In the storage battery the electricity first produces a chemical effect. This action may then be reversed to produce an electrical current.

When a current of electricity flows through a solution of water, in which a small quantity of ordinary table salt has been dissolved, the water of the solution will be broken up or decompoesd into its component parts—Oxygen and Hydrogen.

Let us suppose that current from two dry cells is caused to flow through two platinum wires, the ends of which are immersed without touching each other in a glass of salt water. The current must flow through the solution of salt and water, and in doing so will decompose the water into Hydrogen and Oxygen. Bubbles of Hydrogen gas will rise from the wire through which the current leaves the solution, and Oxygen gas will be liberated at the wire through which the current enters the solution.

Now, if we should suddenly disconnect the wires from our dry battery and connect them to a sensitive electric measuring instrument, we should find that a current flows through the wires FROM THE GLASS OF SALT WATER. Closer investigation will show that the small amount of Oxygen and Hydrogen clinging to the wires in the glass had gone back into solution as water, and in so doing had given back in the form of electric energy part of the energy required to liberate them from the solution.

In the sample experiment above outlined, we have described the action of an elementary and very inefficient storage battery; but the reader will have noted the ability of the electric current to produce a chemical effect, and the ability of chemical action to cause a flow of electric current.

Let us carry our investigation a bit further. We substitute for our solution of salt and water one composed of sulphuric acid and water, and instead of using platinum wires in the solution, we immerse strips of lead. When we pass our electric current through one lead strip, thence through the solution and out at the other strip, the water is decomposed as before into its elements, Hydrogen and

Oxygen. However, instead of the Oxygen being liberated in the form of gas bubbles at the strip through which the current enters, it combines with the lead strip to form lead oxide, which is of a reddish brown color.

Now, if we disconnect the source of current and attach our measuring instrument, or volt-meter, to the conductors leading to the apparatus described we find that an electric current flows for a considerable length of time. The Oxygen, which combined with the lead strip to form lead oxide, recombines with the solution, leaving the plate in its original form as metallic lead when the current has altogether ceased to flow.

The operation of "charging" or decomposing the solution, or electrolyte, may be repeated, and the complete operation of causing a current of electricity to produce a chemical effect, and then, in turn, causing chemical action to produce a flow of current is known as a "cycle."

It would be noted in both the experiments described that the current flows in a reverse direction in discharging; that is, if the charging current flows INTO the solution at one strip, it flows FROM the solution at the same strip when discharging. We should further note that no matter how small or how large we made the lead strips, the force of the current discharged from the cell would be about two volts. Our little apparatus contained in a glass tumbler would give rise to the same voltage as the largest storage cell built. However, should we measure the amount of current and the time it flowed from the solution, we would find that these quantities varied with the size of our strips.

We have in this second experiment described the operation and essential parts of the ordinary storage battery. While any school boy could construct this simple battery of lead strips and sulphuric acid solution, the design and production of a commercially practicable storage battery involves a tremendous amount of detailed refinement.

The storage cell of commercial practicability is made up of the following parts:

A jar, or container, usually made of rubber.
Positive and negative plates.
Separators between the plates.
Solution of electrolyte, and
Covers and connectors.

The plates are made by pasting the active material on a grid of lead alloy. The grid serves to support this active material, which dries on the grid as a porous mass, exposing a far greater amount of surface to the action of the solution than could be done if a solid strip of plate were used.

After the plates are prepared in this manner, they are placed in a lead-lined tank containing a solution of sulphuric acid and water. Current is passed through the plates and solution, as shown, the current entering through half the number of plates and leaving through the other half. The solution is decomposed, liberating hydrogen at the negative plates (the ones through which the current leaves the solution in charging) and liberating oxygen at the positive plates (through which the current enters the solution in charging).

The hydrogen combines with the oxygen of the negative plate, tending to make it pure metallic lead. The oxygen combines with the oxygen already present on the positive plate, changing its form to the brown oxide of lead described in our second experiment. This initial charging is termed "forming the plates." After they have been formed, the plates are placed together in groups of alternate negatives and positives, held apart by the separators.

It has been found in practice that placing two separators between each pair of plates gives the best results. One of these consists of a piece of wood, deeply grooved on one side. The other is a thin, perforated sheet of hard rubber. In assembling, a rubber separator is placed on either side of each positive plate, and a wood separator is placed between each pair of plates, with its grooved side against the negative plate. The group of positive and negative plates is of such dimensions as to practically fill the rubber jar in which it is finally placed, leaving only the pores in the plates, the spaces in the separators and a small space above and below the plates to be filled with the solution of acid and water.

The durability of a storage battery depends first upon the care with which the little details of design and construction are worked out, and after that upon conditions under which the battery is kept in proper condition to perform its functions efficiently.

We have already noted that a cell of a storage battery delivers current at the rate of two volts, regardless of the size of the cell. Therefore, if we require a current with a force of six volts, we must use three cells. The size and number of plates in each cell will depend upon the amount of current needed, and the length of time during which it is required. If our three cells were only required to light one small lamp for a short length of time, we could use very small cells. However, if we require current to crank a large automobile engine for any considerable period of time, we should require more surface in our plates, and should use cells containing quite a number of fairly large plates.

It is an easy matter to increase the capacity of a battery so that for a given weight it will discharge a proportionately large amount of current. This may be done by using a large number of very thin plates. Or, the rubber separators may be discarded, leaving room in the cell for a greater number of plates. Often both these means are used, and a battery is built having very thin plates with only wood separators between them. Naturally, the thin plates have a shorter life than the thicker ones, and durability is further sacrificed when the rubber separators are omitted.

Any storage battery manufacturer who knows his business can build batteries with either thin plates or thick plates, and either with or without rubber separators.

One must be very careful in selecting a battery for a given purpose to insure the greatest ultimate efficiency in the service under consideration.

We have already pointed out the fact that satisfactory service from a storage battery depends very largely upon the manner in which it is charged. The battery must be FULLY charged. It must not be overcharged. If the first condition is not met, the system at once becomes inefficient. If overcharging be permitted, the life of the battery is shortened.

It has been repeatedly asserted that overcharging does no harm to the battery, but this statement has never been made by a reputable storage battery manufacturer. We need only pause for a moment to consider the action in a battery to be convinced of the damage resulting from overcharging. So long as the battery is not fully charged, there is a ready combination between the elements of the solution and those of the plates. When the battery is fully charged, there is no longer any material in the plates with which the elements of the solution may combine, and they must be discharged from the solution in the form of gas bubbles, exactly as the gases were released in the first experiment described. This bubbling or "boiling," as it is called, results first in rapid evaporation of the water of the solution, and if the water is not renewed frequently to replace this evaporation, the plates will be exposed to the air with harmful results. The second and more serious effect of this boiling action is to loosen the active material from the plates. This material crumbles away and falls to the bottom of the jar. Under these conditions the battery will soon become useless. A battery which under proper charging conditions might last for three years, could very easily be put out of commission in three months by continued overcharging.

Batteries should be inspected immediately upon receipt to see that solution covers the plates.

If solution has been spilled by rough handling in transit, refill the cells with electrolyte of 1.285 degrees specific gravity (1 part concentrated sulphuric acid with 3 parts of pure water).

Always give the batteries a freshening charge at finish rate shown on name plate as soon as batteries have been received and inspected.

If batteries are kept in stock for any length of time, give them a freshening charge once a month at the finish rate shown on the name plate.

Always use the oldest batteries in stock.

All batteries are stamped with a letter on the connecting strap indicating the month of shipment, for instance—use batteries lettered "A" before those "B," etc.

Always give the batteries a freshening charge at finish rate shown on name plate before applying battery to car.

Only place the battery in the car immediately before shipment, eliminating the possibility of having the battery discharged when testing or inspecting the car.

CONDENSED INSTRUCTIONS

1st. Examine each cell upon receipt of the battery. If electrolyte has been spilled and does not cover the plates, fresh electrotype should be added.

2nd. Inspect each cell once a week in summer time, and once every two weeks in winter time, and **refill with pure water** if necessary.

3rd. Use only pure water to replace losses from evaporation. Add acid only in special cases where electrotype has been spilled.

4th. Preferably take specific gravity reading when battery is inspected, to check performance of generator.

5th. If battery is falling behind, have the battery recharged immediately and locate the trouble.

6th. Keep the box containing the battery perfectly dry. If any acid is spilled into the box, wipe it off carefully with a piece of waste dipped in ammonia water.

DETAILED INSTRUCTIONS WHEN RECEIVING THE CAR

Immediately upon receipt of the car, the battery should be inspected—the plugs should be removed from the individual cells, and if the solution is not level with the hole in the bottom of the expansion chamber or inside cover, it should be filled to this point with pure water. If it is found that any of the acid has been spilled in transportation, the battery should be filled with a solution composed of one part sulphuric acid and three parts water.

PERIODS OF INSPECTION

The battery should be inspected once a week in summer time and once every two weeks in winter time. At these inspections, all the vent plugs should be removed to ascertain the level of the electrolyte, which is lowered from evaporation of the water in the electrolyte. This evaporation should be compensated for by adding pure distilled water, no acid, to the cells, to bring the solution up to the level of the inside cover.

SPILLED SOLUTION

Acid should only be added when replacing spilled solution. In case the solution has been spilled, it should be compensated for by adding electrolyte or battery solution, which is composed of one part pure sulphuric acid and three parts water by volume.

SPECIFIC GRAVITY

The specific gravity of the battery should read between 1.280 and 1.300 when the battery is fully charged. The specific gravity is a check on the machine and indicates whether the machine is performing properly and is keeping the battery fully charged.

It is, therefore, advisable to take specific gravity readings in the cells at the time the regular inspection is made and before any water is added to the cells. The specific gravity is taken with a hydrometer syringe as shown in Fig. 5.

If the machine is performing properly and is keeping the battery fully charged, the gravity will read between 1.280 and 1.300 from time to time. If the machine is not charging the battery properly it may be due to any of the following causes:

1. Insufficient output from the generator.
2. Too extravagant use of electricity.
3. A leakage of current through a ground.
4. A break in circuit between generator and battery.

First, ascertain if generator is giving its proper output. This is done by connecting an ampere meter in the circuit between generator and storage battery. After the ampere meter has been so connected, run the car at a speed of 15 miles an hour and note amount of current shown by ampere meter. If less than normal, look to your generator and have it adjusted so as to give its proper output.

If the generator is shown to have it rated output, then stop your engine, to ascertain if there is any leakage of current. When engine is still, if the ampere meter shows current flowing from the battery, no matter how little, examine the wiring, lamp connections or other circuits for a ground and remove the same.

If the battery has fallen behind it should be removed from the car and charged according to the rates given on following pages.

CARE OF BATTERY WHEN NOT IN USE

When the battery is not to be used for some time, the owner of the car should arrange so that he can run his engine and charge his storage battery at least once every two weeks. It is not necessary to run the engine for a long period of time, only sufficient to bring the battery up to its full capacity.

Every owner of a car should have a specific gravity hydrometer. At intervals of two weeks, as mentioned above, the engine should be run until the gravity of the solution is up to 1.280. If this is done regularly every two weeks, it will be necessary to run the engine for only about an hour. If the owner of the car does not possess a specific gravity hydrometer, the engine should be run from two to three hours every two weeks to allow a safe margin. It will be much more economical and easier to use the hydrometer than to guess at the length of time necessary to operate the engine. To charge the battery properly, the engine should be run at a speed that will equal a car speed of twenty miles per hour.

When the owner of the car finds it necessary to store the car and not operate it at all, it may be inconvenient to do this charging. In this case, we would recommend the owner, if he has electric current available, to purchase what is termed a rectifier. These rectifiers are moderate in price and consist of a small apparatus to be attached to the wall and plugged into an ordinary lamp socket.

A charge over-night or for about twelve hours once every two weeks with this apparatus, will be sufficient to keep the battery in healthy condition.

If the owner does not wish to incur the expense of this apparatus, the next best thing is to remove the battery from the car and take it to a garage which makes a business of charging batteries, and have it charged every two weeks. The battery should be kept in a dry place.

When charging a battery it should first be inspected to see if it is filled with solution. If the solution needs replenishing, distilled water should be added until solution reaches the height of the inside hole in each cell, which may be seen by removing the vent plug and looking down into the cell.

I strongly recommend charging the battery on the car by its own dynamo and engine if possible.

INSTRUMENTS

A low-reading voltmeter and a hydrometer syringe are necessary in order to obtain correct indications of a battery's condition. The voltmeter reading simply shows the electrical pressure at the time of reading and only partially indicates chemical conditions. A hydrometer reading shows conditions of the electrolyte and is therefore the more reliable source of information. Preferably, both instruments should be used.

I furnish a suitable hydrometer, shown in Fig. 5, and low-reading voltmeters may be purchased at any electrical supply store.

CONDENSED INSTRUCTIONS

1st. Examine each cell upon receipt of the battery. If electrolyte has been spilled and does not cover the plates, fresh electrolyte should be added.

2nd. Give the battery a thorough charge at the FINISH rate as soon as received.

3rd. NEVER let the battery stand discharged.

4th. Charge immediately upon removing from the car.

5th. Voltage readings should be taken only while charging or discharging.

6th. Do not let the battery get warm; its temperature should never exceed 100 F.

7th. Use only PURE water to replace losses from evaporation. Add acid only in special cases.

8th. Each time you charge, bring the gravity up to maximum or charge until it has remained constant for at least one hour in every cell.

9th. When charging the battery, put in at least 20 per cent more current (ampere hours) than is taken out, and at every third charge give it a 50 per cent over-charge at the finish rate for the general good of the battery.

10th. Voltage readings are only approximate. Gravity readings give correct indications.

11th. Keep the box containing the battery perfectly dry. If any acid is spilled into the box, wipe it off carefully with a piece of waste dipped in ammonia water.

12th. When charging at the finish or 24-hour rate, leave battery on until bubbles begin to rise in the electrolyte, then for at least one hour longer.

DETAILED INSTRUCTIONS

PUTTING THE BATTERY INTO SERVICE.

Immediately upon receipt of the battery the solution should be examined. The plugs should be removed from the individual cells and if the solution is not level with the hole in the bottom of the expansion chamber or inside cover, it should be filled to this point with pure water. If it is found that any of the acid has been spilled in transportation, then the jars should be filled with a solution composed of one part pure sulphuric acid and three parts water.

Immediately after such inspection and filling the battery must be charged until its voltage has reached its maximum (2½ volts per cell with battery temperature at 70 degrees F.) and then overcharged for four hours at the 24-hour rate.

The rate for overcharging may be lower than the finish charging rate; but should **not** be higher if it is necessary to leave the battery on for a long period of time.

PERIODS OF INSPECTION

Every time the battery is charged it should be inspected carefully and the solution brought up to the proper height.

DISCHARGING

The discharge from the battery should be stopped when the cells are down to an average of 1.80 volts per cell or 5.40 volts for three cells. This will insure their giving the best life and capacity.

RECHARGING

It is best to always recharge immediately after taking the battery out of the car. Allowing the battery to stand discharged shortens its life.

When batteries are to be recharged, **be sure to connect the positive pole of charging source to positive terminal of the battery.** Start the charge at a rate equal to the normal charging rate (Start) or lower, and continue the charge until the cells gas freely. This will ordinarily take about six hours. Then continue the charge for six hours at the normal rate (Finish), see following pages.

Sometimes batteries are injured by being reversed. This is done by attaching **positive** terminal of battery to **negative** terminal of charging source. When this has been done the battery will show a lack of capacity and if repeated the battery will be ruined.

To find out which is the positive or negative pole of the charging source, immerse both wires in water containing about 10 per cent of vinegar or other acid. Only a few small bubbles will rise from the positive wire, while the negative will give off larger bubbles very actively. Wires should be kept apart.

Should a reversal occur, put the battery on charge at the 24-hour rate and leave it on for several days. Do not take it off until its voltage and gravity both have reached a maximum with battery at normal temperature, 70 degrees F.

CHARGING THROUGH THE NIGHT

The 24-hour rate is the one used for charging through the night, and cells charging at this rate may be left on continuously.

If you have no voltmeter nor hydrometer, it is possible to determine when the battery is fully charged by observing when gas bubbles begin to rise from the solution while battery is charging at the 24-hour rate.

VOLTAGE

The voltage taken while charging at the 24-hour rate should be 2½ volts per cell when the battery is full, and 2.60 volts per cell while charging at the normal rate (start, at normal temperature or 70 degree will be found on following pages.

If the temperature is below normal, the voltage at end of charge will be **higher** in direct proportion as the temperature is below normal. When temperature is above normal (70 degrees F.) the final voltage will be **lower** in proportion as temperature is above normal.

Voltage readings, therefore, can only be used as approximate indications of the amount of charge. Specific gravity readings, on the contrary, are not affected to any appreciable extent by temperature or age of the battery.

Lighting batteries should be placed on the line with batteries capable of taking a charging rate higher than that usually given to sparkling batteries, and at all times the batteries should be left on until gravity has reached its maximum and remained stationary at this maximum for at least an hour.

OPEN CIRCUIT READINGS

Open circuit readings are of no value. All readings of voltage should be made while the battery is charging or discharging.

Alternating current cannot be used for charging a battery.

HURRYING A CHARGE

Sometimes an owner desires to give his battery a hurry-up charge. I do not recommend this, but when unavoidable proceed as follows:

Put the battery on at double the "start" rate given for your battery in the table of rates. For example, a Type ELB-100 would be put on at 30 amperes.

Watch the battery's temperature very carefully—do not allow it to rise above 100 degrees F.

Do not leave the battery on at the **double** rate for more than **one** hour. The rate should then be cut down to the **regular** "start" rate.

For an ELB-100, this would be 15 amperes.

As soon as the cells again gas freely and temperature starts to rise, cut the rate down to the "finish" rate and complete the charge at this **rate.**

Fig. 5

TEMPERATURE

In charging, the temperature of the battery should never be allowed to rise to a point higher than 100 degrees F. The rise in temperature is usually entirely due to the rate at which the battery is charged. The lower the rate, the lower the temperature of the battery for the same room temperature.

It will be noted that batteries in cold weather do not give as much capacity as in warm weather, and if a storage battery is allowed to remain outside in very cold weather, its capacity will be reduced directly in proportion to the temperature. A battery gives approximately half of its capacity at zero.

SPECIFIC GRAVITY.

The specific gravity should read between 1.280 and 1.300. If a battery is found to have low specific gravity, it is probably sulphated and should be charged at the 24-hour rate for several days or until the specific gravity in each cell has remained constant for one hour or more.

Should the gravity still remain low (refuse to come up), a small amount of pure sulphuric acid should be added to those cells which do not come up and the battery charged again at its finish rate.

When battery is fully charged, the gravity should be approximately the same in all cells.

EVAPORATION AND LOWERING OF SOLUTION

Lowering of solution in regular practice is caused by evaporation of the **water** and should be compensated for by adding pure or distilled water, **not acid,** to the cells to bring the solution up to the level of the inside cover. Acid should only be added when replacing spilled solution. At long intervals some battery solution or electrolyte (dilute acid) may be added when the specific gravity does not reach 1.280 degrees at the end of a thorough charge at the finish rate.

SPILLED SOLUTION

Spilled solution should be compensated for by adding electrolyte or battery solution, which is composed of one part pure sulphuric acid and three parts water by volume.

SULPHATING

Sulphating is the result of either undercharge or allowing the battery to stand for a length of time discharged, and means that the plates have become harder than they should be by having absorbed an excessive amount of sulphuric acid from the battery solution.

If a battery is left standing for a long time discharged, it may be very difficult to bring the plates back to a healthy condition. Usually a long charge of three or four days at a low rate will overcome this trouble. Overcharging at the 24-hour rate is beneficial to the battery at all times.

CARE OF BATTERIES WHEN NOT IN USE

When battery is not to be used for some time, I advise that it be placed in the care of one of our battery stations, where it will be given proper attention until the battery is again to be used. If this cannot be done, add pure water to each cell until solution reaches to inside cover, then charge up to full voltage, and store in a dry place. Inspect the battery once a month, refill with pure water to make up for evaporation, and give it a refreshing charge at the finish rate.

Before placing battery in regular service again, each cell should be carefully inspected to see that electrolyte fully covers the plates, pure water being added if necessary.

The battery should then be given a slow charge until its voltage and gravity both have reached a maximum, and then it should have a few hours overcharge at the 24-hour rate.

INSTALLATION, OPERATION OF REMY MODEL OB.

Generators are designed to run in one direction only. When ordering, it is necessary to specify whether the generator is to run clockwise or counter clockwise, the generator being viewed from the driving end.

Generator must be securely fastened to engine base by capscrews, using only the holes provided for this purpose.

Do not under any conditions drill or tap generator base. In installing the generator special care must be exercised to line up the generator shaft with the driving shaft. A difference in height of either of these shafts will impose undue stress and cause excessive wear on the generator and drive shaft bearings.

The height of the generator or the distance from its base line to the center of the shaft, is 2⅛ inches, and is supplied only in this height.

The battery may be located at any place on the car, on running board, under seat, swung under floor boards, on frame, etc. The polarity of the battery need not be considered when connecting same.

Connect the ammeter or indicator as shown in the wiring plan, then, turn on the lights, motor not running. If the pointer deflects to the Charge side of the dial, reverse battery wires at the junction block.

If there is other electrical apparatus on the car, such as horn, speedometer or trouble light, connect as shown on diagram.

All wiring should be carefully fastened to avoid broken connections due to vibration, and where wires are subjected to oil or water, circular loom should be used.

The Model OB is to be positively driven, either by coupling, gears or silent chain, and at crank shaft speed for four cylinder engines, and at one and one-half times crank shaft speed for six cylinder engines. When setting generator be careful that the brush holders or parts thereof do not make contact with the Motor.

For timing, turn the engine over by crank until No. 1 piston reaches top dead center on compression stroke. Press in on the timing button at the top of the distributor and turn the armature shaft until the plunger of the timing button is felt to drop into the recess on the distributor gear. With the generator in this position couple same to the motor. Pay no attention to the circuit breaker when coupling or setting gears, as the breaker is automatically brought into the correct position, and the distributor segment is in contact with terminal for No. 1 cylinder.

WIRING

The high tension cable from distributor terminal No. 1 is to be connected to the cylinder whose piston is on exact dead firing center The remaining distributor terminals are to be connected up in the firing order of the motor.

The location of No. 1 terminal on distributor is determined by the direction of rotation of armature shaft. When armature is driven clockwise, the terminal for No. 1 cylinder is located on lower left-hand corner of distributor.

When driven counter clockwise, the terminal for No. 1 cylinder is located on lower right-hand corner of distributor.

MAINTENANCE

Two oilers are provided—one on each end plate to oil armature and distributor shaft bearings. Give each three or four drops of oil for each 1,000 miles. Any good light oil will suffice. Do not flood generator with oil. Do not oil commutator.

COMMUTATOR

Long and exhaustive road and laboratory tests have proven that neither commutator nor brushes will require any attention throughout a whole season's use.

As a matter of precaution we advise that an inspection of commutator brushes should be made once a season.

Commutator surface should be clean and bright, but if found to be blackened or rough, should be polished and smoothed down with fine (100) sand paper. Armature should be rotated during this process. **Never use emery cloth for this purpose.** After cleaning commutator as above, carefully blow out all sediment from commutator and generator case.

BRUSHES AND BRUSH HOLDERS

Brushes should be kept in perfect contact with commutator.

Brushes should not stick in brush holders. If necessary, carefully clean both brush and brush holder and remove all dirt and grease.

As previously explained, brushes are of special copper-carbon composition and under average conditions will last indefinitely. If replacement should be necessary from any cause, do not use carbon substitutes, but obtain the special brushes furnished by the Remy Factory, Branch Houses or Service Stations.

The third brush, which is connected to the fieldwinding, is for regulation only and requires no attention, and should never be disturbed.

The fuses used in switch block and relay case are special, and should be obtained only from Remy Factory, Branch Houses or Service Stations. We advise that extra fuses for both switch block and relay case be kept on hand in case of emergency.

In the event of bulb replacement, use Tungsten Filament Bulbs only. 16 candle power for head lamps, 2 or 4 candle power for side and tail lamps; all 6½ volt.

A periodical inspection should be made of wiring, insulation and all connections.

Wiring should be protected against grease, oil and mechanical injury.

GENERATOR INSTRUCTIONS

Use the same consideration for your Automobile Lighting System that you do for the Electric Lights in your house, so don't leave your car standing with all lights burning.

1. Do not run generator with battery disconnected, or disconnect battery with engine running. This would cause fuse in relay to blow.
2. Do not use any other than Tungsten filament bulbs.
3. Do not use bulbs of greater candle power than those recommended.
4. Do not oil or grease commutator, lubrication here unnecessary.
5. Do not replace brushes or fuses with inferior substitutes, obtain the genuine from the Remy Factory, Branch Houses, or Service Stations.
6. Do not ignore battery instructions.
7. Do not start on an extended trip without first inspecting battery.
8. Do not allow battery or wiring connections to become loose.
9. Do not allow wires to chafe on any metallic part of car, as the insulation will be damaged and a short circuit will result.
10. Do not fail to comply with the wiring instructions and consult diagram when connecting or disconnecting any wires.

IGNITION INSTRUCTIONS

Circuit breaker platinum points may be inspected by removing the Bakelite housing cover. The points should have a smooth, clean, flat surface at all times. The break, or gap of these points should be from fifteen to twenty thousandths of an inch. The circuit breaker may, if desired, be removed without the use of tools.

The high tension current is distributed to the spark plug cables by means of a special hard carbon brush making contact with distributor segments. Neither distributor nor brush will require any attention whatever.

An oiler is provided for distributor shaft, a few drops of light oil every one thousand miles will suffice.

We recommend the use of spark plugs which permit of the points being adjusted to a definite gap. The gap between the points should be from twenty to twenty-five thousandths of an inch.

If the motor misses when running idle or pulling light, the plug gaps should be made wider. If motor misses at high speed or when pulling heavy, at low speed, the plug gaps should be made closer.

Proper results will be obtained if these instructions are carefully followed. Remember that there are many things that will cause a motor to miss and act like ignition trouble, (a) carburetor out of adjustment, (b) leaky valves, incorrect valve timing, (c) air leaks in intake manifold or around valve stems, (d) motor not oiling itself properly, (e) lack of compression.

REMEDIES FOR POSSIBLE TROUBLE

ALL LIGHTS GO OUT

Cause—Open or short circuit between switch and battery; examine wiring and contact at battery terminals; examine connections at lighting switch; examine all bulbs.

ALL LIGHTS GO DIM

Cause—Short circuit in wiring from battery to switch. Defective battery. Discharged battery caused by either—leakage of current due to short circuits in wiring; using bulbs of greater candle power than those recommended; or using low efficiency carbon filament bulbs; generator not charging properly, probably due to loose connection.

ONE LIGHT GOES DIM

Defective bulb or connection at lamp. Short circuit or ground in wiring to lamp.

ONE LIGHT GOES OUT.

Either head, side, tail or dash light. Defective bulb or defective wiring between lamp and junction block. Loose connection at junction block of lamp socket.

BOTH LIGHTS GO OUT

Either both head, both side or tail and dash light. Fuse blown in switch, probably due to a short circuit; examine wiring, locate and rectify trouble. Insert new fuse. Loose connection at switch or junction block. Open circuit between switch and junction block.

ALL LIGHTS FLICKER

Cause—Loose connection either at battery, junction block or switch; an intermittent ground or short circuit between switch and battery.

ONE LIGHT FLICKERS

Loose or frayed connection at lamp or junction block. An intermittent ground or short circuit in wiring to lamp. Bulb or connector loose in bulb socket.

AMMETER OR INDICATOR REGISTERS DISCHARGE WITH ALL LIGHTS OFF AND ENGINE IDLE.

Short circuit in wiring from battery to switch or battery to junction block. Ammeter out of adjustment. A simple test to determine the latter cause is to disconnect one of the battery terminals either at battery or in battery line; if the Ammeter hand returns to Zero, it is evident that trouble is leakage of current due to a short circuit, which must be immediately remedied before battery becomes discharged. If the Ammeter hand does not return to Zero, after disconnecting battery it is proof that Ammeter is out of order and should be corrected. It may be possible that Ammeter is out of calibration, and that the Ammeter hand deflects to either charge or discharge side, when engine is idle and all lights off. This will not affect the operation of the generator or lighting system, but this discrepancy must be borne in mind when taking generator charge readings. Another possible, though hardly probable cause, is the Reverse Current Relay points remaining closed, remove cover, which is readily accomplished by loosening two thumb screws, and release relay blade with finger, thereby breaking contact. If this should occur inspect relay points and clean same if necessary. Do not change adjustment of relay blade spring.

AMMETER OR INDICATOR DOES NOT REGISTER CHARGE WITH ENGINE RUNNING AND ALL LIGHTS OUT.

Either Generator or Ammeter defective. Stop engine and switch all lights on. If Ammeter registers discharge it is almost conclusive proof that Ammeter is properly operating, and the trouble exists in Generator. If the Ammeter does not register discharge under the above condition, trouble exists in Ammeter or connections.

TO LOCATE GENERATOR TROUBLE

Remove reverse current relay cover and examine fuse, replace with new fuse if necessary. Start engine and if Ammeter still refuses to register, inspect all generator connections and ascertain if same are tight and secure.

GENERATOR TEST

A simple test to determine if Generator is properly operating, is first, switch all lights on with engine idle, second, start engine and run same reasonably fast. If lights brighten perceptibly after starting engine, it proves that the generator is properly delivering current. This test must necessarily be conducted in the dark, either in garage or preferably at night time.

THE STORAGE BATTERY

Old Type—The old type of storage battery was made up of lead plates and dilute solution of sulphuric acid testing about 1.25 sp. qr. This solution is made up by mixing pure sulphuric acid testing 1.84 with about 4 parts of distilled water, and pouring enough of this into the cell to cover the plates.

Care should be taken to not get any of the acid solution on clothing or any machine parts, as it rapidly eats the fabric or rusts the parts. Do not put this acid in any vessel other than glass, rubber or earthenware.

New Type—The new Edison is much easier to handle, as it has an iron container and cobalt and nickel plates with an alkali solution which does not destroy parts as does sulphuric acid.

Charging—Connect the battery to the charging wires so that the positive wire leads to the positive connection on the battery, and place a 3-way socket in one side of the circuit with three 32 cp-110 volt electric lights as a resistance. This will give you 1, 2 or 3 amperes of current as you insert one, two or three of these lamps

Do not charge too rapidly. If the battery be a 60-lamp horn cell, it will require 20 horns; either using the three lamps (3 Amp.) or 30 horns if two lamps are used. Test for voltage only and when fully charged this battery should test 6.6 volts.

After using, the pressure begins to drop and the battery must be recharged when the pressure has dropped to about 5 volts.

It will not require as much time to recharge this time, as a large part of the charge is still retained.

To charge more than one battery at a time, connect the batteries together in series as you connect dry cells, positive to negative, etc., and use the same current. About 2 volts in pressure is lost in each batting and if, say, 20 batteries were connected so as to be charged at the same time, this would cause a pressure drop of about 40 volts, and hence, a proportional drop in the current from 3 Amp. to about 2 Amp. To overcome this a less resistance must be placed in the circuit.

It is not advisable to depend on the above scheme for resistance if many batteries are to be charged. A regular rheostat should be provided.

If too large a charging or discharging rate is used, the plates will heat up and buckle, causing a short circuit and ruining the batteries.

Table of Charging Rates

Starting Batteries

15

SSB-68	3	6	80	12	4	4	2½	7½	11	6	10½
SSB-610	3	6	100	14	4¾	4¾	2½	7½	12⅜	6	10½
SSB-612	3	6	120	18	6	6	2½	7½	15	6	10½
SSB-123½	6	12	35	6	2	2	2½	15	12¾	6	10½
SSB-125	6	12	50	8	2¾	2¾	2½	15	15⅜	6	10½
SSB-126	6	12	60	10	3¼	3¼	2½	15	18	6	10½
SSB-163½	8	16	35	6	2	2	2½	20	16½	6	10½
SSB-165	8	16	50	8	2¾	2¾	2½	20	20	6	10½
SSB-166	8	16	60	10	3¼	3¼	2½	20	23½	6	10½
SSB-183½	9	18	35	6	2	2	2½	22½	16	6⅞	10¾
SSB-185	9	18	50	8	2¾	2¾	2½	22½	16	8¼	10¾
SSB-186	9	18	60	10	3¼	3¼	2½	22½	16¼	9¾	10½
SSB-242	12	24	20	4	1¼	1¼	2½	30	18¾	6	10½
SSB-243½	12	24	35	6	2	2	2½	30	24¼	6	10½
SSB-1210	6	12	100	14	4¾	4¾	2½	15	15⅞	8⅜	10½
STB-125	6	12	50	8	2¾	2¾	2½	15	15⅜	6	10½

Table of Charging Rates

Starting Batteries

14

	Cells	Volts	Normal Capacity Amp Hrs.	Normal Charging Rates Amp. req'd		24 hr. Charge Rate	Volts per cell at end of Charge at 24 hr. rate	Volts of battery at end of charge at 24 hr. rate	Size of battery over all in inches		
				Start	Finish				Length	Width	Height
SLB-68	3	6	80	12	4	4	2½	7½	11	7½	9
SLB-610	3	6	100	14	4¾	4¾	2½	7½	12⅜	7½	9
SLB-612	3	6	120	18	6	6	2½	7½	15	7½	9
SLB-123½	6	12	35	6	2	2	2½	15	12¾	7½	9
SLB-125	6	12	50	8	2¾	2¾	2½	15	15⅜	7½	9
SLB-126	6	12	60	10	3¼	3¼	2½	15	18	7½	9
SLB-163½	8	16	35	6	2	2	2½	20	16½	7½	9
SLB-165	8	16	50	8	2¾	2¾	2½	20	20	7½	9
SLB-166	8	16	60	10	3¼	3¼	2½	20	23½	7½	9
SLB-183½	9	18	35	6	2	2	2½	22½	20½	6⅞	9
SLB-185	9	18	50	8	2¾	2¾	2½	22½	20½	8¼	9
SLB-186	9	18	60	10	3¼	3¼	2½	22½	20¾	9¾	9
SLB-242	12	24	20	4	1¼	1¼	2½	30	18¾	7½	9
SLB-243½	12	24	35	6	2	2	2½	30	24¼	7¾	9
PS-68	3	6	80	14	4¾	4¾	2½	7½	9⅜	7¾	11¾
PS-612	3	6	120	18	6	6	2½	7½	12	7¾	11¾

Table of Charging Rates

AUTEX Sparking Batteries

Type	Capacity in amp. hours at sparking rate	Normal charging rates amp. required		24 hour charging rate	Volts per cell at end of charge at 24 hr. rate	Volts of battery at end of charge at 24 hour rate	Size of Battery over all in inches			Number of Cells
		Start	Finish				Length	Width	Height	
X-2	40	5	2	2	2½	5	3¾	6¾	8½	2
X-3	40	5	2	2	2½	7½	5	6¾	8½	3
Y-2	60	7½	3	3	2½	5	5½	6¾	8½	2
Y-3	60	7½	3	3	2½	7½	7½	6¾	8½	3
Z-2	80	10	4	4	2½	5	6⅜	6¾	8½	2
Z-3	80	10	4	4	2½	7½	8⅞	6¾	8½	3
V-60	60	7½	3	3	2½	7½	9¾	5⅜	9¼	3

Table of Charging Rates

Lighting Batteries

	Cells	Volts	Normal Capacity Amp Hrs.	Normal Charging Rates Amp. req'd		24 hr. Charge Rate	Volts per cell at end of Charge at 24 hr. rate	Volts of battery at end of charge at 24 hr. rate	Size of battery over all in inches		
				Start	Finish				Length	Width	Height
ELB-65	3	6	50	8	2¾	2¾	2½	7½	8½	7½	9
ELB-66	3	6	60	10	3¼	3¼	2½	7½	9¾	7½	9
ELB-68	3	6	80	12	4	4	2½	7½	11	7½	9
ELB-610	3	6	100	14	4¾	4¾	2½	7½	12⅜	7½	9
ELB-612	3	6	120	18	6	6	2½	7½	15	7½	9
ELB-123½	6	12	35	6	2	2	2½	15	12¾	7½	9
HSB-65	3	6	50	8	2¾	2¾	2½	7½	8½	6	10½
HSB-66	3	6	60	10	3¼	3¼	2½	7½	9⅜	6	10½
HSB-68	3	6	80	12	4	4	2½	7½	11	6	10½
HSB-610	3	6	100	14	4¾	4¾	2½	7½	12⅜	6	10½
HSB-612	3	6	120	18	6	6	2½	7½	15	6	10½
PD-60	3	6	60	7½	2¼	2¼	2½	7½	8	4½	9¼
V-60	3	6	60	7½	3	3	2½	7½	9¾	5⅜	9¼

THE REMY ELECTRIC LIGHTING AND STARTING SYSTEM

The illustration of the Remy electric lighting and starting system, Fig. 8, will be the next illustration which we will take up. First, we must start to finding out the way our motor fires in order to wire this system up so that it may work properly on the gasoline engine As this has been explained in the pages before this, you will readily see that a No. 1 cylinder is on compression and your distributor and interrupter is properly set. In Fig. No. 8, you will notice that the positive wire is connected from positive on the generator to "Y" on the induction coil. You will notice that "R" connects to the interrupter No. 11. You will notice "G," the ground wire, connects to interrupter No. 10. We must lead a wire to the storage battery so it is carried to the starting switch No. 3; from there it leads to the positive point of the storage battery No. 2. This current then again must return back to the generator from where it started; after passing through the storage battery it leaves the negative point No. 6, where it returns back to the starting motor; from the starting motor, passes to the ammeter No. 17; from there it passes to the lighting switch No. 16 and then returns back to the dynamo negative from where it started. We know that the current must leave the storage battery and leave the dynamo in order to pass to the lights, so it leaves the storage battery from the positive; it leaves the dynamo from the positive. Either current from either direction will come to the starting switch No. 3; from there it can pass to the lighting switch No. 16; from there it passes through each light and returns back to the lighting switch where it will return to the dynamo, to the negative from where it started. If returning to the storage battery, it will return back through the ammeter No. 17 where it will then return to the negative of the storage battery from where it started, No. 6.

We also know that the current leaving the dynamo or leaving the storage battery must pass through the induction coil so that you will notice the wire that is connected from "R" to the interrupter, No. 11, the ground wire "G," then leads to the ignition switch No. 8 where then the current passes through and returns to the lighting switch No. 16, and then returns back to the negative of the dynamo. If coming from the storage battery, passes down to "Y" 13, then through the interrupter from No. 12 and out of the interrupter to "G" No. 9, then to the ignition switch, through the ignition switch where it returns to No. 16 at the lighting switch; from there to the ammeter No. 17, then returning back to the storage battery to the negaive No. 6 from where it started.

In connecting a set of dry cells, you will notice that we do not use extra wires; no more than is necessary, so we run one wire from the dry cells over to No. 3 at the starting switch, as that will reach "Y," or No. 13, or will reach the electric horn from the lighting switch No. 16. This set of dry cells are used for only starting, which is not necessary. We also use them for running the horn. The storage battery will start the engine as easily as the dry cells.

You will notice the horn is connected to the ignition switch and from the other side of the horn is connected to the push button where it is fastened on the side door, then it returns back to the lighting

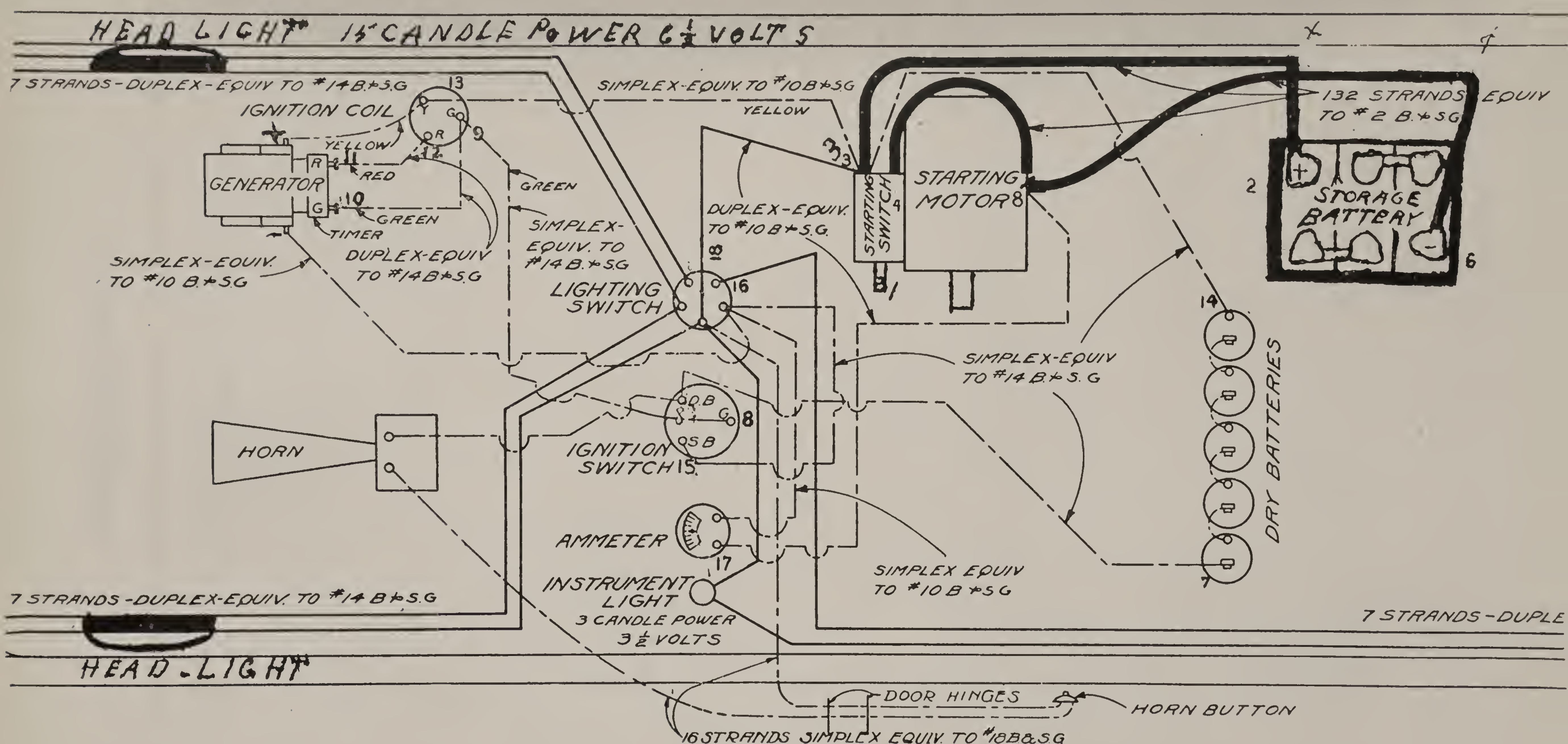

HEAD LIGHT 15 CANDLE POWER 6½ VOLTS
7 STRANDS-DUPLEX-EQUIV TO #14 B.+S.G
IGNITION COIL
13
YELLOW
GENERATOR
RED
GREEN
TIMER
DUPLEX-EQUIV TO #14 B+S.G
SIMPLEX-EQUIV. TO #10 B.+S.G
SIMPLEX-EQUIV. TO #10 B+S.G
YELLOW
GREEN
SIMPLEX-EQUIV. TO #14 B.+S.G
LIGHTING SWITCH
DUPLEX-EQUIV. TO #10 B+S.G.
STARTING SWITCH
STARTING MOTOR
132 STRANDS EQUIV TO #2 B.+S.G
STORAGE BATTERY
HORN
IGNITION SWITCH
AMMETER
INSTRUMENT LIGHT
3 CANDLE POWER
3½ VOLTS
SIMPLEX-EQUIV TO #14 B.+S.G
SIMPLEX EQUIV TO #10 B+S.G
DRY BATTERIES
7 STRANDS-DUPLEX-EQUIV. TO #14 B+S.G
7 STRANDS-DUPLE
HEAD-LIGHT
DOOR HINGES
HORN BUTTON
16 STRANDS SIMPLEX EQUIV. TO #18 B&S.G

FIGURE NO-8

switch where it goes to No. 3 at the starting switch and returns to the dry cells.

Now we will start the full cycle of this system, tracing the illustration lines of Fig. No. 8 as the engine would be in operation. First, push down the starting switch which closes the circuit at No. 3 at the starting switch. The current leaves battery positive, passing to No. 3 through the starting switch, through the starting motor, returns to negative of storage battery. This puts starting motor in motion, which puts engine in working power. This causes the revolving of the generator in which the current leaves the generator, passing to the cut-out relay. From there it returns to positive; from positive it passes to "Y"; from "Y" it passes to No. 3 at the starting switch, then to the positive of the starting storage battery, where it returns out to negative to No. 8 and through the ammeter No. 17, returns to lighting switch 16 and back to the negative of the generator. Where this generator may be putting out 15 amperage, there will be 2½ pass through the induction coil at "Y" and come out on "R" passes to interrupter and through the interrupter and back to "G" No. 9; there passes to the ignition switch No. 8 and passes over to "SB" then returns back to the lighting switch 16, or returns back to the generator. This causes a line of force to take place in the induction coil, which line of force is broken by breaking the current in the interrupter which increases a high pressure in the secondary winding which passes to the center of the distributor and then is distributed to the cylinder which is on compression stroke dead center at that time. This causes the power stroke of that cylinder. If the current should return from the storage battery through the induction coil through the motor running too slow to generate a current from the dynamo, it would pass from positive of the storage battery No. 2, passing to No. 3, then to "Y" No. 13 at the induction coil, through the primary winding out at "R" No. 12 to the interrupter No. 11, through the interrupter out on No. 10 to "G" No. 9, then would pass to the ignition switch No. 8 where it would pass across to "SB" and then to the lighting switch No. 16, passing to the ammeter 17 and through to the starting motor No. 8, then back to the storage battery to the negative point No. 6. This would do the same work as just mentioned through the current of the generator passing through the same source. If the current should be carried to the lights through turning the switch on, the current would leave the generator from the positive, passing to "Y" only to pass on to No. 3 at the starting switch, where it would pass then to the lighting switch No. 16, then out to each and every light and return back to the negative of the generator where it started. If the current came from the storage battery back to the lights through the motor standing still or not running fast enough to generate a current, the current would leave positive No. 2, passing to No. 3 at the starting switch; it would pass to the lighting switch No. 16, then through each and every light, where it would return to the ammeter No. 17 back to the starting motor No. 8, then returning to the negative No. 6. If starting on the dry cells, the current leaves No. 7, passing to the starting switch "D B," then across to "G," passing down to "G" No. 9, passing through the interrupter at No. 10, coming out at No. 11 to "R" No. 12, passing through the primary winding, coming out at "Y," returning to No. 3 at the starting switch, then returning back to the negative No. 14 at dry cells. This does the same work by passing through the primary winding as the current that has passed through just mentioned. If the circuit is closed to the electric horn, the current leaves the positive point at the dry cells where it passes to "D B" then to the horn; through the electric horn to the horn button, then to the lighting switch No. 16, then to No. 3 at the starting switch and returns back to the dry cells No. 14.

This illustration that I have just carried you through, would be well for you to trace this current over a great many times before you will be able to memorize it. You should practice drawing this illustration until you can draw it without looking at it. This is the only method of learning a thing by heart.

STARTING

Closing the starter switch through pressing the foot pedal connects the starting motor with the battery, as illustrated by diagram, this circuit being entirely complete and independent of the lighting circuit. The battery current gives necessary power to the starting motor to crank the engine through the gearing.

After the starter has cranked the engine for a reasonable period, ten to fifteen seconds, the engine will start on its own power. Failures to start promptly are often due to faulty ignition, poor carburetion, or other similar troubles encountered in hand cranking. Don't expect the starter to take the place of your engine, it is not designed for motive power. Don't waste time or battery current on the starting equipment in the belief that it is solely up to the starter to crank the engine until it runs on its own power.

CARE

Should be taken to see that all wiring is in good condition, that all connections are kept tight and clean, as failure of the motor to operate when the switch is closed indicates either a corroded or loose connection in the starting circuit, which may exist either at the battery, starting switch, or starting motor, or may be the cause of a broken battery cell, a battery almost discharged, a short circuit or a ground. The starting motor itself comprises merely a shell containing four field poles with their windings, the armature, and the brushes. It is, therefore, evident that the failure of the starter to start will only, in remote cases be traceable to mechanical troubles in the motor. The removal of the nickel-plated end cap allows ready inspection of the brushes and commutator, and should these ever require attention, same should not be tampered with by anyone unless thoroughly familiar with this class of work, or can follow instructions implicitly.

Starting systems are installed for the purpose of cranking the engine and for that purpose only. To test the strength of the starting equipment by having it propel the car involves an unnecessary strain on the starter and gearing and a foolish waste of battery current and this practice should be resorted to only in extreme or necessary cases.

DEACO 6-VOLT ELECTRIC LIGHTING GENERATORS.

The Generator with the Storage Battery connected by wires through the Automatic Cut-out, forms a complete and independent electrical circuit, and has for its purpose the supply of electric current to the battery to replenish that consumed for starting, lighting, and other purposes.

The action of the generator in the manufacture of electric current has already been described, power from the engine rotating the armature in a magnetic field at engine speed or 1½ times engine speed, the design being such that on the average car, the lamp load is balanced at a driving speed of 12 miles per hour. Inasmuch as the average driving speed is upwards of 15 miles an hour, a supply of current in excess of that required for the lamps is assured at all times, this being sufficient to keep the battery charged and in a healthy condition even if little day driving and considerable night driving is maintained.

The output of the generator is held to 15 amperes maximum output for engine speed generators and 12 amperes maximum output for 1½ times engine speed generators. The maximum output is reached at about 20 miles per hour driving speed, and at higher driving speeds begins to taper off slightly in rate of charge. This regulation, or means for keeping the current supply from the generator to safe limits, regardless of engine speeds, is attained in a very simple manner, without the use of any auxiliary devices whatsoever.

The control of output is by armature reaction, that is, the design and connections of the machine are such that as the speed increases, beyond the determined or maximum output, the current in the armature begins to react on the current in the fields, causing the field current to become weaker, which in turn affects the output of the machine. This entire regulation is obtained by means of a small brush to which one side the field winding is connected. This small brush is offset from the main brushes, the degree of offset being determined by the output desired. The shifting of these brushes, therefore, has much to do with the output and regulation of the generator, and tampering with these brushes, other than an occasional inspection and cleaning of commutator and brushes, should be refrained from. The terminals of the generator are not marked × or — as with this design of generator, it will automatically find its proper polarity when connected to the battery. With no trappy controlling devices, only one part, the armature rotating, a construction rugged and simple, little or no trouble should be encountered, if common sense treatment and usage is accorded these devices.

The automatic cutout is for the purpose of preventing the battery from "discharging" itself, through the windings of the generator, when the speed of the generator is too low to put a charge into the battery. This automatic cutout is a simple electro-magnet connected to the generator, operating contacts which connect the battery with the generator when the generator produces sufficient voltage to charge the battery, and disconnect the battery from the generator at speeds below six miles per hour.

DEACO LIGHTING AND STARTING SYSTEM ILLUSTRATION.

You will find the Deaco system a very simple and easy system to trace on which the cut-out relay is shown as an open view, which the light wire is a shunt winding; the heavy wire is the series winding. The gap at "G" will be noted an open point in which the current can not pass through until this core through the winding has become magnetized. You will notice the starting motor is connected at the fly wheel. This comes enmesh through the closing of the starting switch which moves the gear enmesh with the gear on the fly wheel.

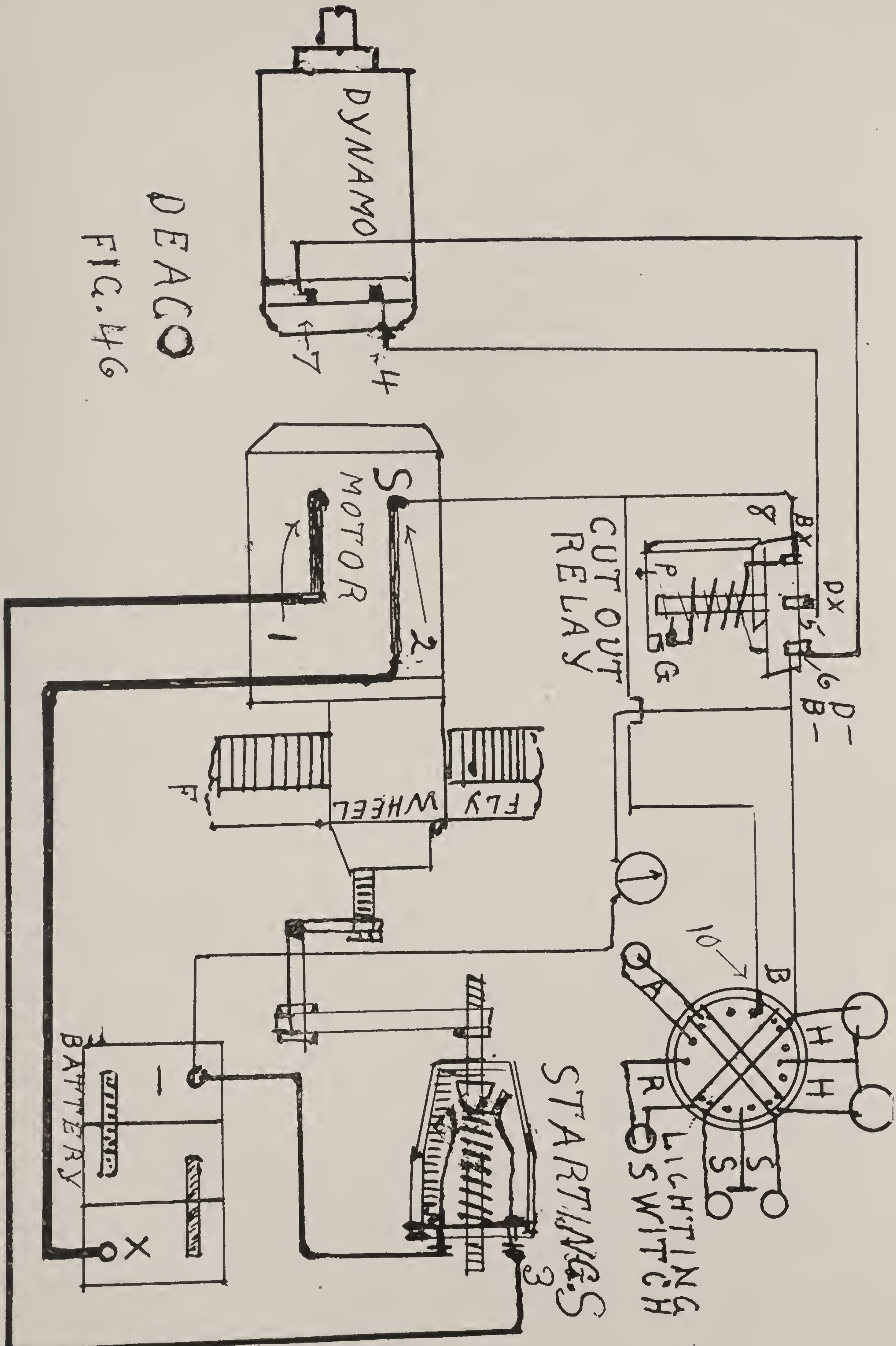
The dynamo is a type when put onto a current that is capable of keeping the storage battery fully charged, if the proper amount of lights are used and accidents of shorts are avoided.

In first wiring this up, it is necessary on this system to know the positive and negative points, although you will find these systems are supposed to be so that they can be connected without connecting them wrong, no difference which point is connected, positive or negative, as the polarity of the battery is bound to be right. This is through the winding of the dynamo, but it is very easy matter for you to find the positive point if you desire by connecting a wire to the positive and negative, then drop it in a glass of strong acid vinegar. The wire which bubbles greatest is the negative, the wiring which has a few bubbles coming from it is the positive.

The positive point of a dynamo must always lead to the positive point of the cut-out relay "D." The positive here is No. 5. This cut-out relay is always marked. Then there must be a wire returning back to the dynamo from "D" negative at the cut-out relay which is No. 6; then the current that leaves this cut-out relay always leaves at "B" positive, where it passes to the positive point of the storage battery. It isn't necessary to lead a wire clear to the storage battery, so we connect it at the starting motor No. 2, as this wire leads to the positive point of the storage battery.

The return current comes from the negative point of the storage battery. It isn't really necessary to fasten the wire from the negative, but can be fastened from the starting switch terminal, which leads to the negative point of the storage battery. This wire must always be fastened to an ammeter if you have one. The current must always pass through the ammeter after leaving the storage battery or just before entering the storage battery, but must always be connected on the small wire, but never connected at the large wire between the starting motor and the storage battery. The other wire that leads from the ammeter on the return current must be fastened to "B" and "D" negative, where it makes its return to the dynamo, the point of starting.

The lighting switch which we have here is a switch in which you turn once, it gives you the side light, tail light and speedometer. The next turn throws the side lights out and gives you the head lights. One more turn gives you all the lights, and one more turn, turns them all out, so it is necessary for you to connect the wires to the lead from "H" marked on the lighting switch. The side lights connect to letter "S" marked on the lighting switch; the speedometer and rear light connect to "R B," must be connected to the storage battery which


DYNAMO
MOTOR
S
CUT OUT RELAY
FLY WHEEL
BATTERY
STARTING S
LIGHTING SWITCH

DEACO
FIG. 46

can be connected to No. 6 "B" and "D" negative and to No. 8 "B" positive, and it makes no difference which wire is connected to which, nor the wires which lead to the lighting, it makes no difference which is connected to which side of the lighting switch; it will work either way.

Now in starting the engine, we first turn on the ignition switch and then push down on the starting switch, when this current leaves the positive point of the storage battery passing to the starting motor No. 2, going through the starting motor, leaving at No. 1, it returns to starting switch No. 3, where it passes through the starting switch at a low resistance, then returning to negative of storage battery. After this, the starting of the motor, turning very slowly, brings the gears enmesh at the fly wheel, then the starting switch is forced on it, which puts it in full cranking power. After this has been done, the current leaves the dynamo at No. 4, where it passes to "D" positive No. 5, passing across the plate at "P" it passes through the shunt winding then passes out at No. 6 "B" and "D" negative, where it returns to the dynamo No. 7. This causes the core to become magnetized, which draws the points together, closing the gap at "G," then the current leaves the dynamo at No. 4 positive, passing to "D" positive No. 5, where it passes across the plate at "P" to the point at the gap; as it is closed now it passes through the series winding and out at "B" positive No. 8, then passing to the starting motor at "S," leaving over to positive of storage battery where it passes through the storage battery and out at the negative, passing through the ammeter, returns to "B" and "D" negative, where it returns to the dynamo, the point of starting.

When the lights are turned on, if this machine is putting out 15 amperage, 15 amperage leaves the dynamo, passing to "D" positive, passing across the plate to "P," over through the gap "G," leaving "B" positive No. 8 where ten amperage passes across to the lighting switch "B" No. 10, and the other five passes down to "S" through to positive of the storage battery through to the negative and out at the ammeter, showing a charging rate of 5 amperage leading to "B" and "D" negative, where the ten amperage passes through the lighting switch to each and every light, returning back to "B" and "D" negative, where it returns to No. 7 from where it started. Should we stop the engine, or the motor should be running so slowly that it would not be generating, a current would leave positive of storage battery leading to our lights, it would pass to No. 2, where it would pass to "B" positive and undertake to go through the series and discharge by passing out at "D" positive and through the dynamo, out at 7, back to "B" and "D" negative where it would return through the ammeter and back to the storage battery at negative. To prevent this, the current passing through at No. 8, through the series winding in the opposite direction from what that current was passing before, it changes the polarity which demagnetizes the iron core allowing the two points to fly apart at the gap "G" where the current can not pass through any longer, but must pass to No. 10 at the lighting switch and to each and every light, it returns to "D" and "B" negative, where it returns through the ammeter, showing a discharge and back to the negative of the storage battery from where it started.

JUNIOR DELCO LIGHTING AND STARTING SYSTEM WHICH IS USED ON THE BUICK.

This system is a ground system; by that I mean one side of the connections are fastened to the frame of the motor. When we speak of the ground on an automobile we speak of the frame only and not of the earth.

The junior Delco is a very simple system; very easy to take care of and is adopted on a good many different cars.

At the ignition relay No. 1, you will notice that we have connected a set of dry cells; these dry cells are merely for starting only. At No. 3, at the ignition relay, we connect the ignition coil to No. 4; from No. 2 at the ignition relay, we connect to No. 2 at the induction coil. From No. 3 the high tension wire is connected to the center of the distributor. No. 1 is connected to the dry cells also. From the dynamo No. 1 and No. 2 the large wire is connected to the positive point of the storage battery. From the negative point of the storage battery is connected to the frame of the car. No. 2, on the motor generator, we connect to the lighting switch, to the horn button, also to the horn and to the frame. From the lighting switch on the opposite side, we connect and wire to each one of the lights and from the other side of the lights to frame. From No. 2 on the induction coil, we connect the wire to the breaker box No. 2, where the other end of it grounds. In the distributor we wire No. 1 to No. 1, No. 2 to No. 2, No. 3 to No. 3 and No. 4 to No. 4, which would make the fire 1, 2, 4, 3. The operation of this is such: Turning the ignition switch to No. 2, the current leaves the dry cells at No. 5, passes to No. 1, from No. 1 to No. 3, and No. 3 to the frame of the motor; from the frame of the motor to the interrupter No. 2, passing to the induction coil No. 2, through the primary winding to No. 1, to No. 3 at the ignition switch, No. 2 at the ignition switch, and back to the dry cells from where it started. While passing through here it creates a line of force which the ignition relay creates a line of force vibrating, but breaks the line of force, inducing a high pressure in the ignition coil No. 3 to the center of the distributor from the center of the distributor No. 1 spark plug, back over the frame of the motor to the ground wire and back into the ignition coil No. 4 from where it started.

The primary current takes place with the breaker points together; when the breaker points break apart, then the current must leave the dry cells from the point No. 5, passing to the ignition relay No. 1, and then to No. 2 on the ignition relay. From 2 it passes to No. 2 on the ignition coil, but can not flow to No. 2 at the breaker box as the two points are broken apart. For that reason, it passes on through the ignition coil and to No. 3 at the ignition switch, to No. 2 at the ignition switch and back to the dry cells from where it started. As it does not go through the winding at the ignition relay to cause it to vibrate, there is no current broken and as the current isn't broken, the lines of force do not break in the ignition coil and for that reason, there is no spark being delivered while the two points on the breaker box are apart. Otherwise, it would seem that there would be a continual vibration.

When the motor has been started, the current then comes from the generator. It passes from the generator through the cut-out re-

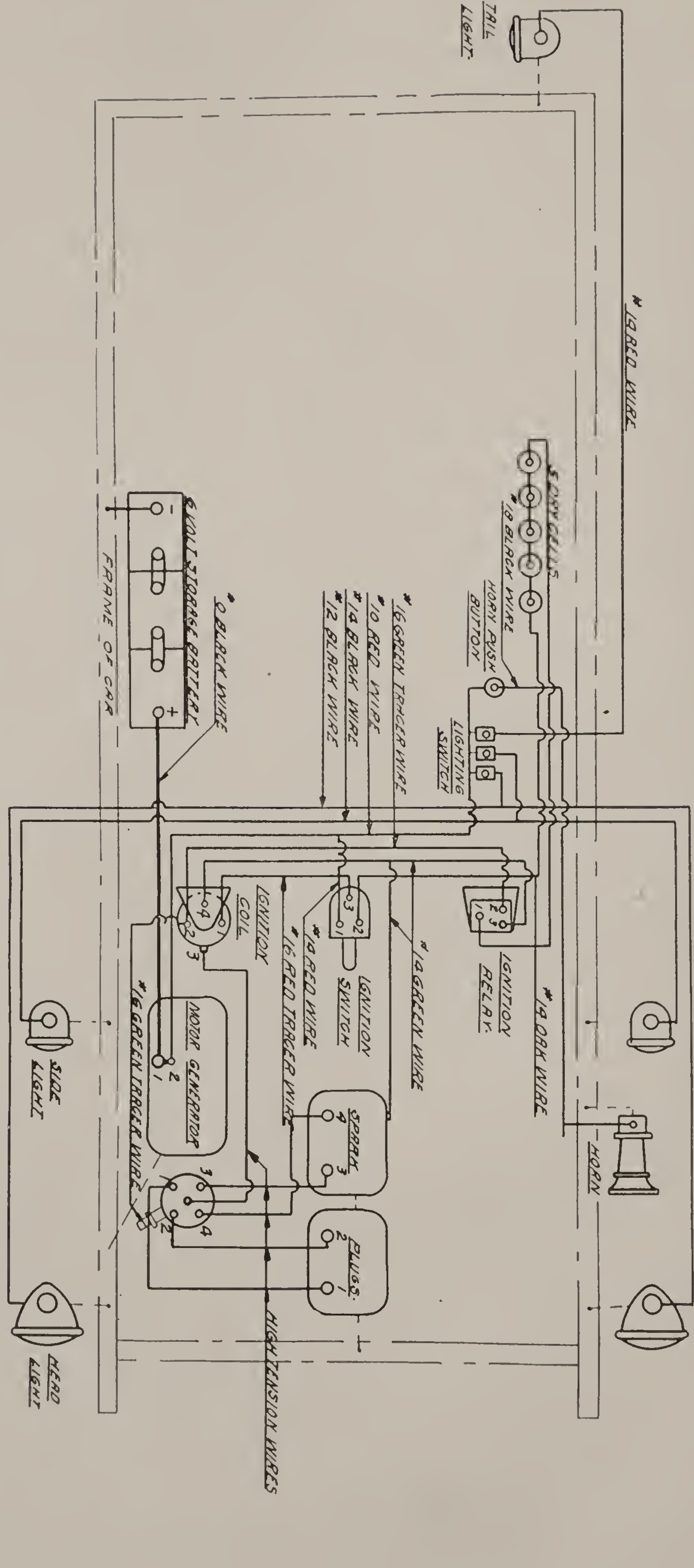

TAIL LIGHT
#14 RED WIRE
6 DRY CELLS
#18 BLACK WIRE
HORN PUSH BUTTON
LIGHTING SWITCH
IGNITION RELAY
#14 DRK WIRE
HORN
6 VOLT STORAGE BATTERY
#0 BLACK WIRE
FRAME OF CAR
#16 GREEN TRACER WIRE
#10 RED WIRE
#14 BLACK WIRE
#12 BLACK WIRE
IGNITION COIL
IGNITION SWITCH
#14 GREEN WIRE
#14 RED WIRE
#16 RED TRACER WIRE
MOTOR GENERATOR
SPARK
PLUGS
#16 GREEN TRACER WIRE
SIDE LIGHT
HEAD LIGHT
HIGH TENSION WIRES

Fig. 17

DELCO

lay inside the generator, through the shunt winding and back to the armature winding from where it started. This creates a line of force in the cut-out relay, closing the series circuit, from which the current leaves the dynamo, passes through the series winding, then passes to No. 2 at the dynamo. From 2 it passes to No. 1 at the ignition switch to No. 3 to No. 1 at the ignition coil, to the primary winding, to No. 2, and from No. 2 to No. 2 at the interrupter, and then over the frame back into the dynamo from where it started. While passing through here, it creates a line of force; a line of force is broken by the breaker at the breaker box No. 2, breaking this current, it breaks the line of force which induces a high pressure in the secondary winding, which leaves No. 3, passing to the distributor to No. 2, and No. 2 spark plug back over the frame of the motor, the ground wire and back into No. 4 and induction coil from where it started. When the lights are turned on, the current leaves No. 2 at the dynamo, passing over the wire to the ignition switch and dividing and going on to the lighting switch, where it passes to each and every lamp, returning back over the frame of the motor to the ground of the dynamo from where it started; where the rest of the current that goes to the ignition switch passes on through the coil as just described.

When there is a current flowing from the generator to the storage battery, it passes from No. 1 to the storage battery positive, through the storage battery to the negative, back over the frame to the ground of the generator from which it started.

When the lights are being used and the generator is not in operation, the current then must come from the storage battery, passing from the positive to No. 1 of the generator. It can not pass through the generator and short, returning to the storage battery on account of having to go through the cut-out relay, and going through the cut-out relay in the opposite direction, will change the polarity, causing the two points to fly apart, breaking the series circuit; therefore, the current will pass from No. 1 to No. 2. As this point is an insulated point on the dynamo there is no way for a current to short here at No. 1 and No. 2; passing from No. 2, passes to the lighting switch and from there to each and every light, off on the frame and returns to the storage battery again from where it started.

The Junior Delco is a very simple system and if you will study this illustration carefully, you should have no trouble in wiring a Junior on most any car with which you may come in contact. The method of learning these drawings is by practicing drawing the illustrations until you can draw it without looking at it. You will find sometimes by trying to make the drawing that you will make mistakes; then study where you have made that mistake and try to draw it again; by doing so you will finally master your drawing until you are capable of making the drawing without looking at it. Also practice tracing the current; once you have mastered this, you will be able to master any drawing that you may come in contact with. If it should be a magazine of some new electrical starter that has been put out, it will be easier for you to master it and understand it by studying and practicing these drawings you have here. All electric lighting and starting systems work on the same principle. There is no reason, after you have studied these carefully that you have in this book, but that you ought to be able to master any electric starting device that you may come in contact with. It is the same thing over and over with each and every system. They must be made a little different so as not to infringe on other people's patents, but the working principle is the same.

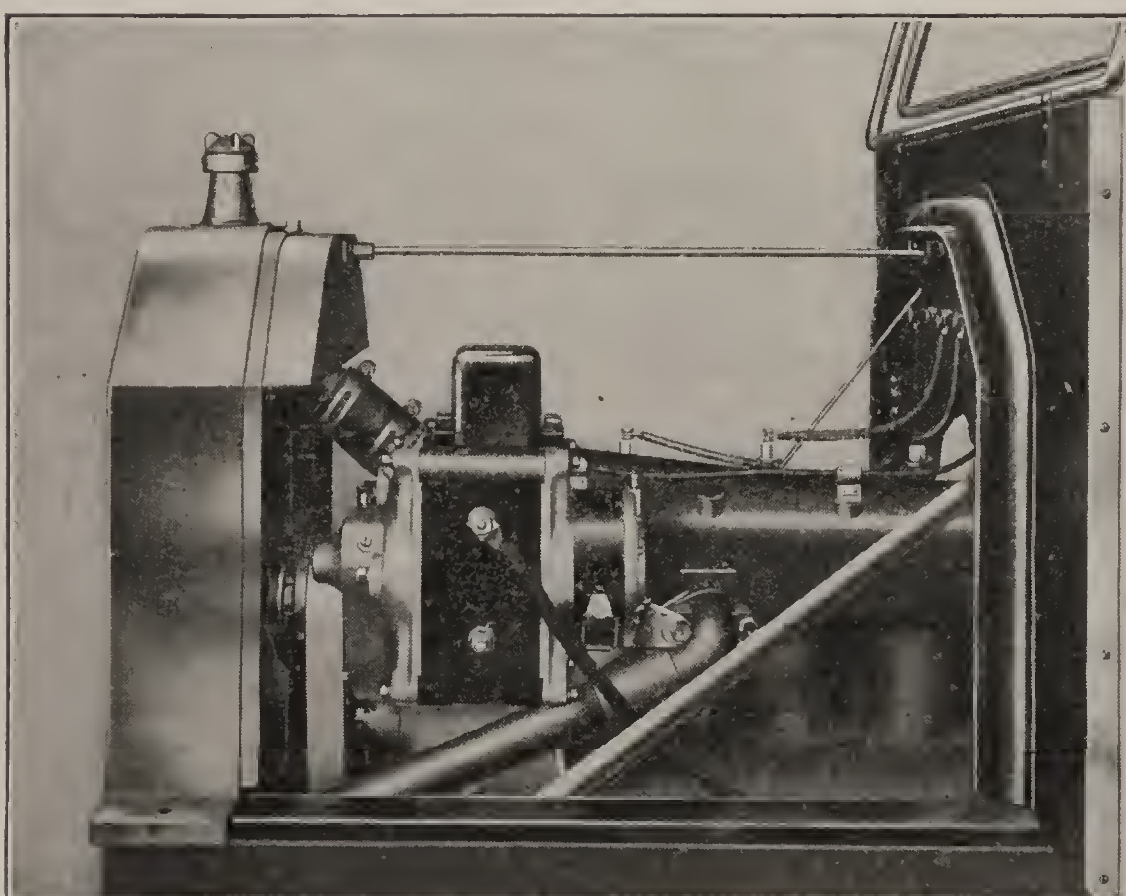


FIGURE NO. 44

This illustration shows a Gray & Davis Generator and Starter equipped on a Ford car, which is adapted for this certain car and other cars as well, but this certain generator is adapted especially for the Ford and has proved very satisfactory in every way. You will find the illustration showing a wiring diagram on Figure No. 51.

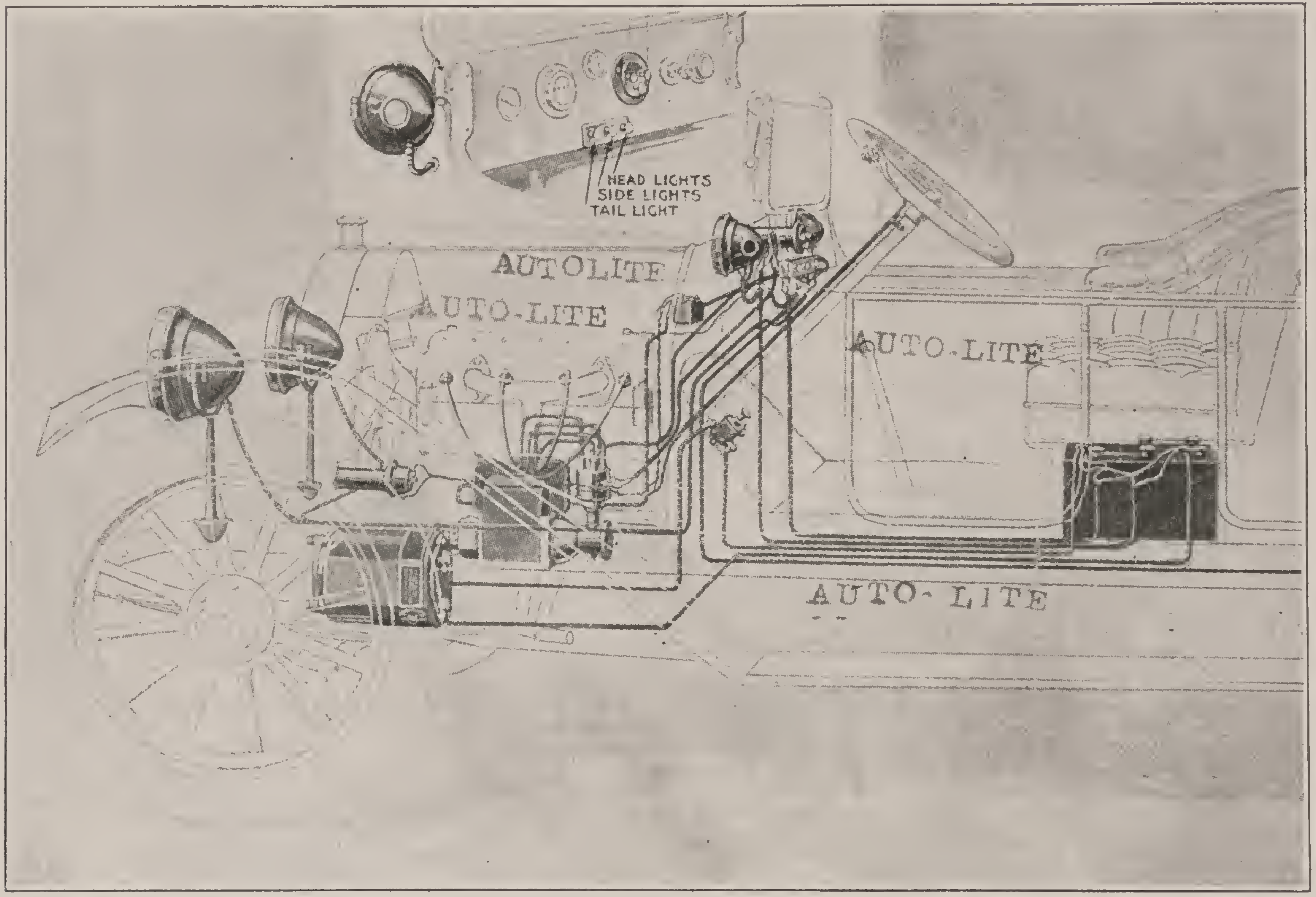


FIGURE NO. 45

Figure No. 45 shows a wiring of an Auto-Lite, which is being shown here on the Chevrolet car, otherwise is known as the Baby Grand. This shows the system just as it would look on the car ready for work. We show a complete wiring of this illustration in Figure No. 53.

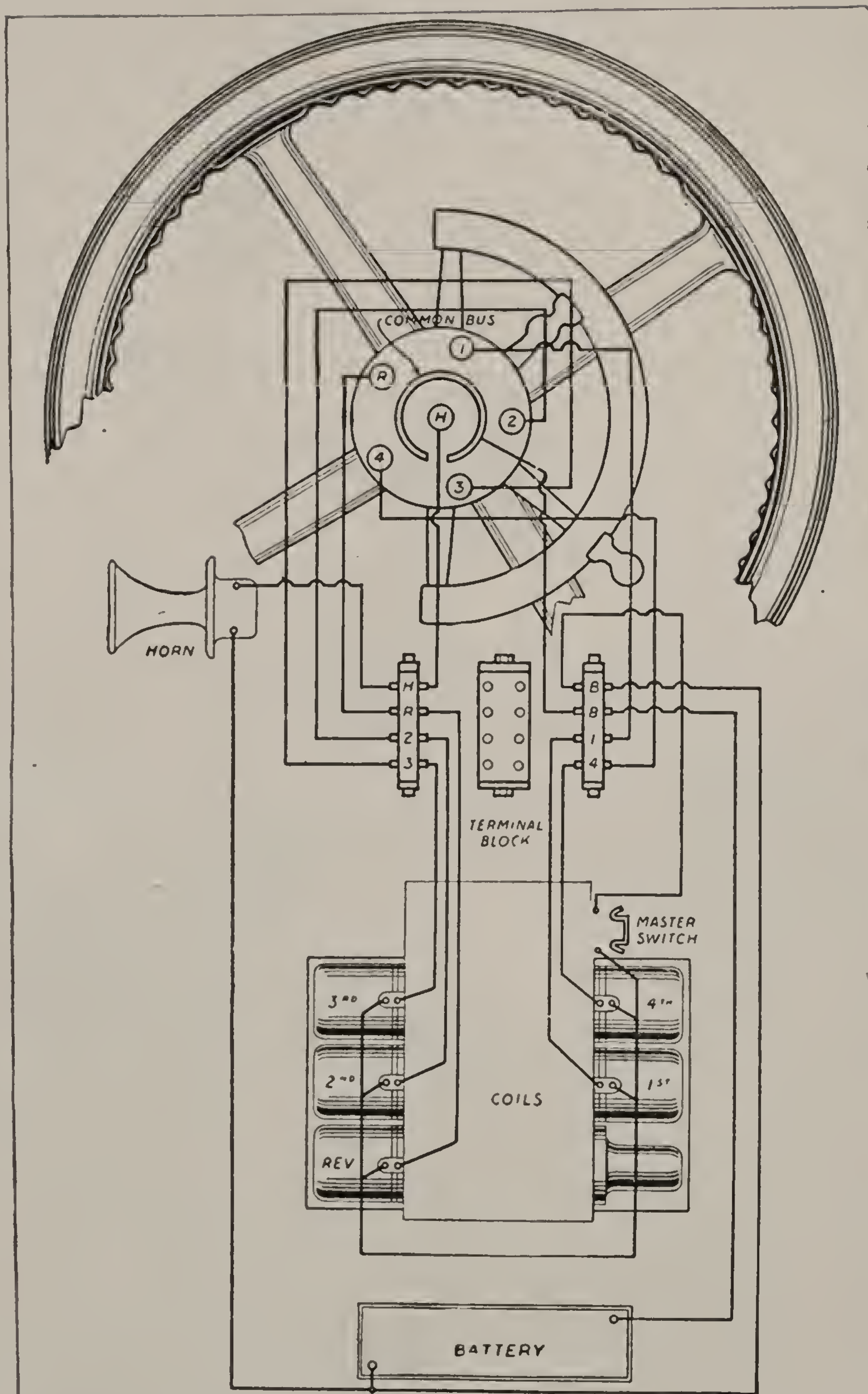


Fig. 15

Wiring Diagram showing Push Buttons on Steering Wheel, Magnetic Solenoids, Battery and Electrical Connections for a Four Speed and Reverse Transmission

THE VULCAN ELECTRIC GEAR SHIFT

The Vulcan Electric Gear shift may be said to consist of two units—the "shifting assembly" or group of magnets attached to the transmission case, and the "selector-switch" or push button group located on the top of the steering column, in the center of the steering wheel, where it can be easily operated without requiring the driver to remove his eyes from the road ahead or his hands from the steering wheel.

The electric current required to energize the magnets is derived from the storage battery ordinarily supplied as part of the starting and lighting systems on all cars. So slight is the amount of current required to operate the gear shift that it constitutes no appreciable drain upon the energy stored in the battery. In fact, it may be said that the total current consumed in shifting gears does not exceed .005 of an ampere hour, per shift, or sufficient to supply an ordinary set of lamps about 4½ seconds.

THE SELECTOR SWITCH

The Selector-switch which is carried on the wheel is made up of a number of buttons, one for each speed and one for "neutral" which has no electric connection. There is also a button for operating the horn in the center. These buttons are provided with arched, laminated contacts of copper, backed up with a steel spring and insulated from the button proper. The top of the switch carries a locking-plate for locking in button which may be depressed and also carries an interlock, which makes it impossible to press down more than one button at a time. At the bottom is a hard rubber base, which carries a copper contact for each button and a contact common to all speeds. It also serves as a base for a return spring provided for each button.

THE WIRING

The wiring is extremely simple. There is one "lead" passing out each coil through a "terminal" block to its particular speed button on the selector-switch, while the others lead from the coils joined to a neutral wire directly through the terminal block to the battery, with the master-switch intervening, while another wire from the battery passes through the terminal block to the contact of the selector-switch which is common to all speeds. It is easy, therefore, to follow the flow of the current. It travels from the terminal of the battery through all depressed push buttons on the selector-switch down and around the coil selected and then back to the other terminal of the battery. (See Fig. 15.)

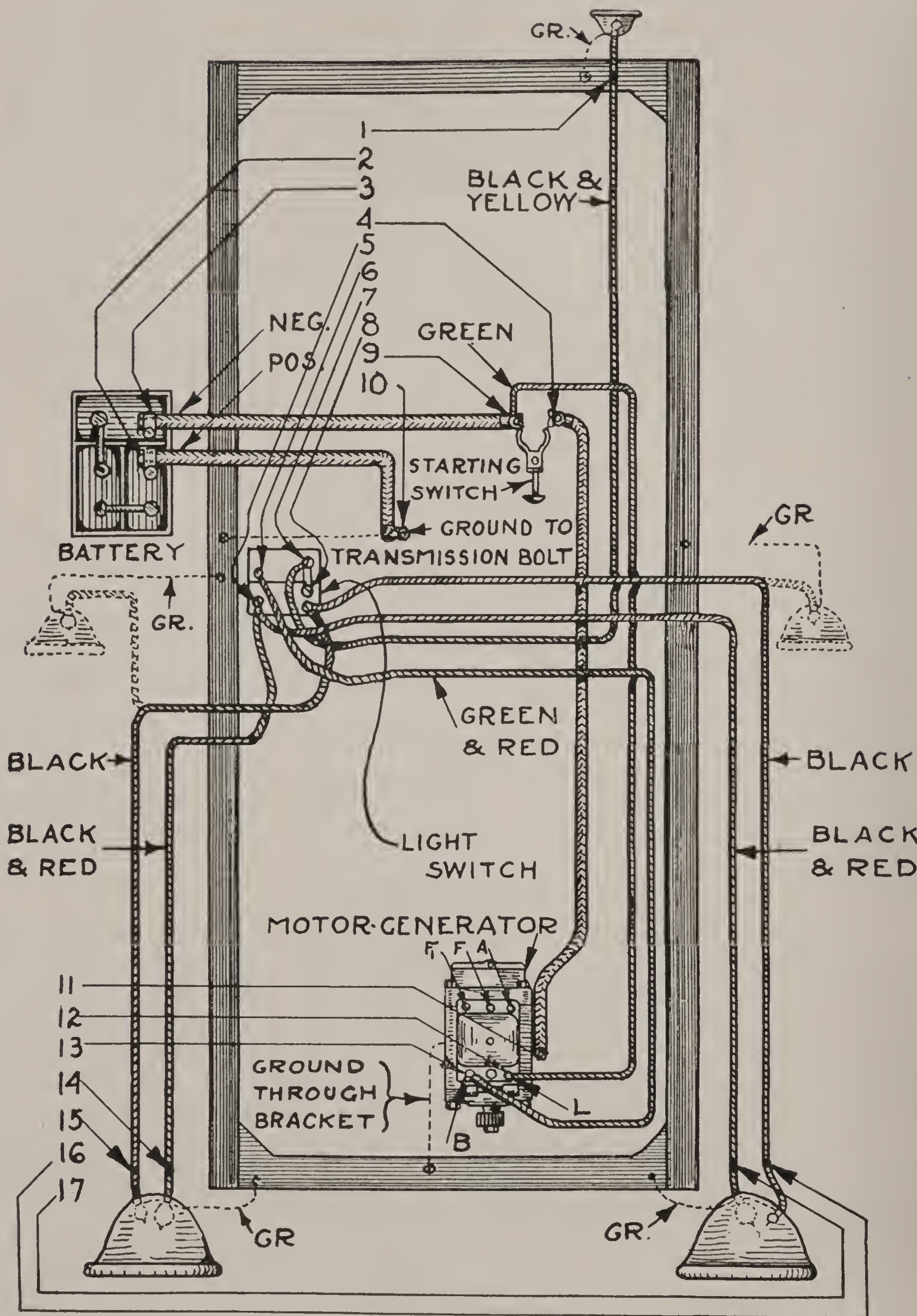

GR.
1
2
3
4
5
6
7
8
9
10
BLACK &
YELLOW
NEG.
POS.
GREEN
STARTING
SWITCH
GROUND TO
TRANSMISSION BOLT
BATTERY
GR.
GR
BLACK
BLACK
& RED
GREEN
& RED
BLACK
BLACK
& RED
LIGHT
SWITCH
MOTOR-GENERATOR
F F A
11
12
13
14
15
16
17
GROUND
THROUGH
BRACKET
L
B
GR
GR.

FIG. NO. 51.

Figure No. 51 shows a Gray & Davis used on the Ford, which you will find working practically the same as the other systems which have been explained. The starting of this I shall explain to you.

The pushing down of the starting switch causes the current to flow from the positive No. 2, where it passes to the ground, then over to the generator, where it passes through the motor brushes and returns over the wire No. 11 to the starting switch and back to the storage battery No. 3, where it started. After the motor has been started, the motor brushes on the commutator raise and the generator brushes are left down; the motor now is a generator in which the current flows over the ground to the ground wire, where it passes into the battery, through the battery out at No. 3, where it passes to the starting switch at No. 9 and over the green wire to the dynamo again from where it started. The current leaving this dynamo must first pass through a cut out relay, passing through the shunt, closing the series, and then passing through the series winding before leaving the dynamo. In case the lights are turned on, the current can pass to the lights, and back over the wires to the lighting switch, and from the lighting switch over the wire No. 7 to the light, from the generator over the frame to each and every light, then to the lighting switch where it will pass from No. 6, passing to the generator No. 13, where it will pass back to where it started from. In case the generator is not in motion, the current then will come from the storage battery, where it passes from No. 2 positive to the ground to the frame where it will pass to each and every light, passing back to the lighting switch to No. 6 to the dynamo No. 13, to No. 12, and back over the green wire into the storage battery from where it started, No. 3.

ILLUSTRATION OF A DELCO SYSTEM AS USED ON A PACKARD.

The Delco is a compound wound motor, putting out high pressure at times and will always put out enough current to keep the battery fully charged. I have known of storage batteries to be run clear down and starting the motor, recharging the storage battery back again until it would start the motor from its own current and build it back again until the lights were perfectly bright. This proves that this machine will put out plenty of current to supply its battery. It is also taken care of by the means of a volt regulator. This is wired the same as most any other system. We have at No. 21 an interlock switch which must be closed before the circuit cam flow from closing the starting switch. We also have at No. 2, 7 and 12 a knife switch. This is thrown across when the starting switch is forced in; at No. 38 there is a resistance coil to prevent from too heavy charging due to the different temperature of heat. It can be regulated for winter, summer, spring and fall.

At No. 35 and 34 you will notice the cut-out relay which opens the same as on the other systems. The fine winding at the dynamo is the field winding of the dynamo. The heavy winding is the field winding of the starting motor. This fine winding point must be connected from No. 5 to the volt regulator 39. From No. 14, which is the dynamo terminal, leads to the ammeter 35, passing through the ammeter where it passes to the knife switch 12, and then through the cut-out relay and back, which is connected from this point to the cut-out relay and the positive point of the storage battery.

From the starting motor terminal No. 7, the wire is connected to the negative point of the storage battery No. 11. From the field winding of the starting motor, is connected at 3 where the knife switch makes connection and passes to the positive terminal of the storage battery. The wire is connected from negative of the storage battery No. 11 to the interlock switch and to the cut-out relay at 24; from the cut-out relay there is a wire leads from 18, and from the interlock switch to No. 18. The operation of this current operates as such: First, close the interlock switch No. 21, then push the starting switch. If the current leaves positive and passes from No. 1 to No. 2 at the knife switch, where it passes through the ammeter and then to No. 14, passing through the armature out at 18 and through the field out at 5, over to the volt regulator through 39, where it passes through the mercury of the volt regulator, through the small pin, then passes through the winding, out at No. 40, then it passes through the regulator 38, passing up to 17, it passes across to 18, through the interlock at 20, through the gap 21 to 22 and back to No. 11 negative, from where it started. This starts the motor to turning over slowly which brings the gear enmesh with the fly wheel. Then the starting switch is pushed on down, which throws the knife switch across from No. 2 to No. 3, where the circuit is closed, and puts the motor in full cranking power, and the current leaves positive No. 1, where it passes from 2 to No. 3 over the wire to No. 5, through the field winding back through the commutator No. 6, through the armature winding out over the large wire No. 7, it returns back to 28, where it passes to No. 11 and to the storage battery from where it started. This puts the motor in power which causes the clutch to let go as the dynamo is being turned faster and causes the other clutch to take hold. This turns this as a dynamo through the interlock switch flying out and the knife switch as sliding back into its place; the current then leaves the dynamo through the pressure increasing in the field winding, which passes to the volt regulator No. 39, then passing through the mercury, causing heat, it passes out at 40 where it passes through the regulation of the winter and summer regulator, passing through the resistance of 33, where it passes to 17 and then back to the field winding from where it started. This brings a pressure up at the field which causes the current to increase in the armature winding, which leaves the armature at No. 14, passing to the armature 35, going through the ammeter, it passes to No. 12 at the knife switch, where it passes up over the wire No. 38, passing through the shunt winding 35, it passes over the wire 35, 18, 17 and back to 18, from there to 15 in the dynamo from where it started. This causes the core to become magnetized at the cut-out relay, which draws the two points together at 24, closing the series circuit. The current then leaves 14, where it passes through the ammeter 35 and then through the knife switch 12 to No. 2, passing to the positive point of the storage battery No. 1, out at No. 11, it passes to 22 then to 24 through the series 34 and out at 25 over 18, 17, and back to 18 into 15 from where it started. This current passing through here charges the storage battery.

In case the motor is speeded up so that it would start to generat-

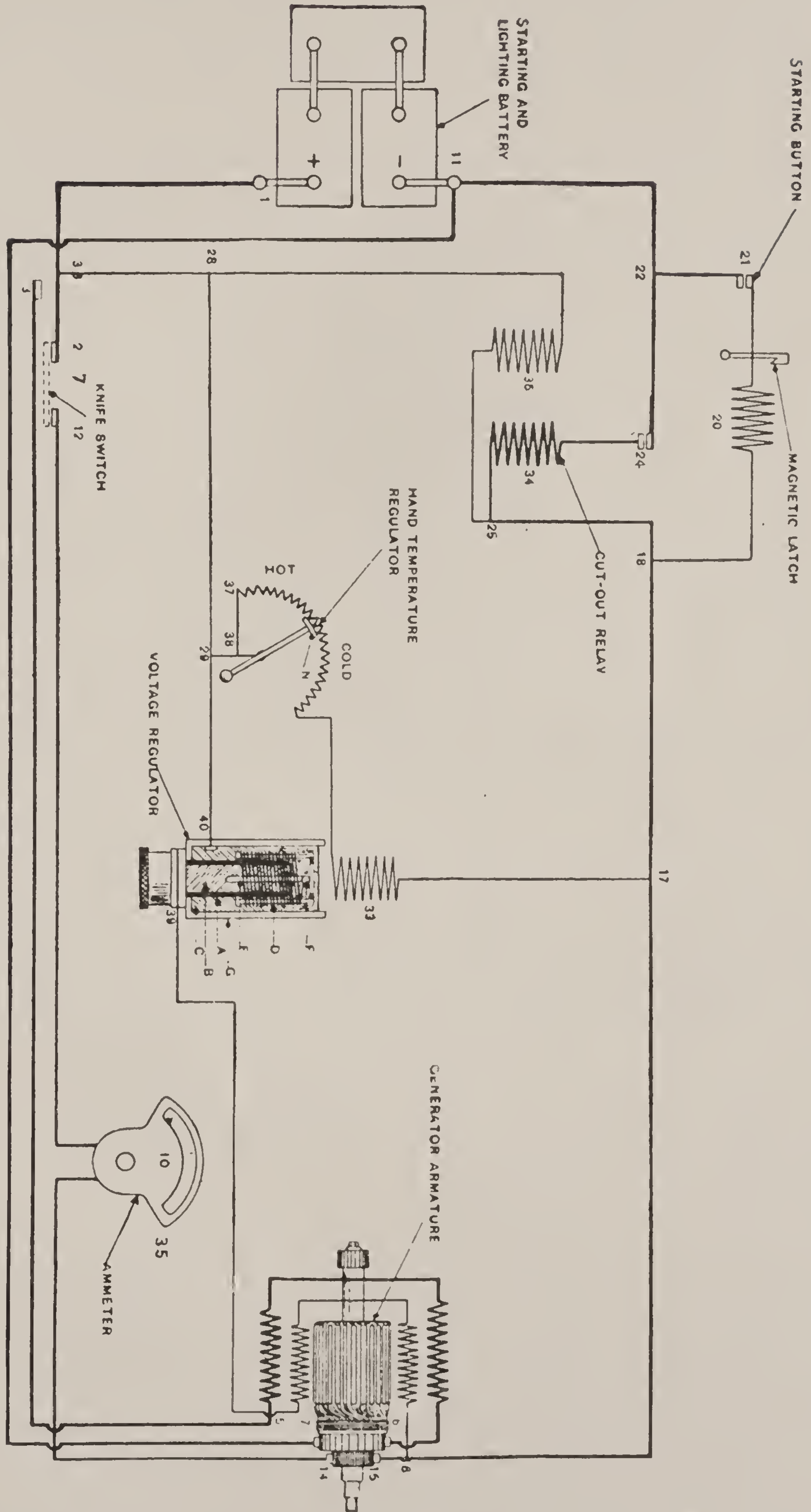


Fig. 20.

SIMPLIFIED DIAGRAM OF DELCO SYSTEM AS USED ON THE PACKARD.

ing a higher current, the result would be a pressure would back up at the volt regulator and this would cause the pressure to decrease at the field winding. The pressure decreasing at the field winding will cause the current to decrease in the armature winding. The moment that the machine drops, its speed pressure will decrease at the volt regulator causing the pressure to back up at the field winding which will cause an increased current in the armature winding. This working vice versa keeps the pressure or current at one certain point at the dynamo. This is governed through this volt regulator No. 40. It has a small needle coming through the center; as you will notice No. "F" points towards the top of this needle. This needle is in the mercury which makes connection with the circuit flowing through the mercury, which the mercury heating causes it to rise. As it rises it makes connection with the wires or cut-out resistance; cutting out the resistance that allows the current to flow through more freely. When the mercury drops again it causes the resistance to cut in, which makes up a pressure and causes the pressure to decrease at the field. If there should be a battery fully charged, the result is that you can not overcharge this battery as the current that leaves No. 14 passing through the ammeter to 12 and through the knife switch to 2 passing to the positive point, through the battery and out the negative 11. When the battery is fully charged, part of this current divides at No. 38 where it passes across to No. 29 and through the regulator 38, 37 and through the resistance coil 33, where it passes to 17 and back to 18 to the dynamo from where it started. The resistance through this regulator is just enough to prevent the current from coming that way; as long as the pressure is below 6 volts in the storage battery and we raise to 6 volts in the storage battery and above, then the resistance at the storage battery is just as great, if not a little greater; than the resistance of No. 33. If the current should flow from the storage battery back, it would pass through the knife switch and through the ammeter and undertake to go through the dynamo, passing through 18, 17, 18 and 35 at the cut-out relay, where it would undertake to go through 34 and going through the opposite direction, would change the polarity, which would cause this to demagnetize, throwing the two points apart at 24, which would break the circuit. This would not allow the current longer to flow in this direction, so preventing the battery from discharging.

The cut-out relay acts the same as a check valve on a steam engine when forcing water into the boiler by means of an injector; the pressure by which it is forced in is dry steam taken from the top of the steam dome where it is forcing water against water pressure. After this water has been forced in it would return again back out through the injector if it was not by means of a check valve which seats back to its place, preventing the water from returning; so the cut-out relay acts the same as this check valve to prevent the current from flowing back in the opposite direction from the way that it was flowing, and discharging the storage battery through the dynamo.

You will find instead of this system, the Junior Delco is being used on a great many different cars as it is more simple and easier for beginners to operate and to care for.

DIAGRAM OF GRAY & DAVIS LIGHTING SYSTEM

The Gray & Davis system is used on a great many cars. The starting motor is no different from any other series wound. They all work on the same principle and for that reason it isn't necessary to make a drawing of the starting motor as you well understand the connections of any starting motor which you will see in the other illustrations.

The Gray & Davis system as shown here is very simple and easy to learn the tracing of the current and the wiring. You will notice the cut-out relay shows a fine wire which is the shunt leading out to No. 2; the series is a heavy line which leads to No. 3 through the gap, the ammeter No. 5 and No. 6.

The lighting switch, you will notice a return circuit to "S" which is a series through the dynamo. The negative is connected from the dynamo to No. 2 at the cut-out relay, which will be marked dynamo "D and B" negative. The positive of the dynamo leads to No. 1, which will be originally marked dynamo "D" positive, will be marked at No. 3 which leads either to the lighting switch or at the same terminal which leads to the ammeter, or leads to the ammeter and connects from the ammeter to one point at the lighting switch. The lighting switch marked "B" will be connected to "S" at the dynamo where your No. 2 will also lead to the storage battery negative, and from the other side of the ammeter to positive. The current leaving this dynamo passes from the positive dynamo to No. 1 where it passes through the fine winding which is the shunt, passing out No. 2, returns to negative, the dynamo from where it started, or passing through it creates a line of force which causes the iron core to become magnetized; this attracts the spring at the bottom which brings the two gaps together, closing the series. The current then leaves the positive of the dynamo, passing to No. 1, then through the series passing through the two gaps that are together out at No. 3 where it passes to ammeter No. 5; passing through the ammeter showing a charging rate, passes over the red wire passing to the positive point of the storage battery, passing out on the black wire negative, passing to No. 2, and from No. 2 to the negative point of the dynamo from where it started.

The current going to the lights and storage battery, the current leaves positive of the dynamo on the red wire, passing to No. 1, passing through the series winding, passes out on No. 3 or passes to the ammeter No. 5 where the current splits, part of it passing to the lights "B" and out to each and every light, returning back on the yellow wire to "S." The other current passing through the ammeter over the red wire at the storage battery, returning through to the negative back over the black wire to No. 2, back to the negative of the dynamo from where it started. If the current leaves the storage battery through the motor not running or not running fast enough to charge, the current leaves positive over the red wire, passing to No. 6 at the ammeter, through to No. 5, where it passes to the lighting switch, from the lighting switch to each and every light, it returns back at "B," over the yellow wire to "S," where it passes through the series to the negative over the black wire to No. 2, then back to negative of the storage battery.

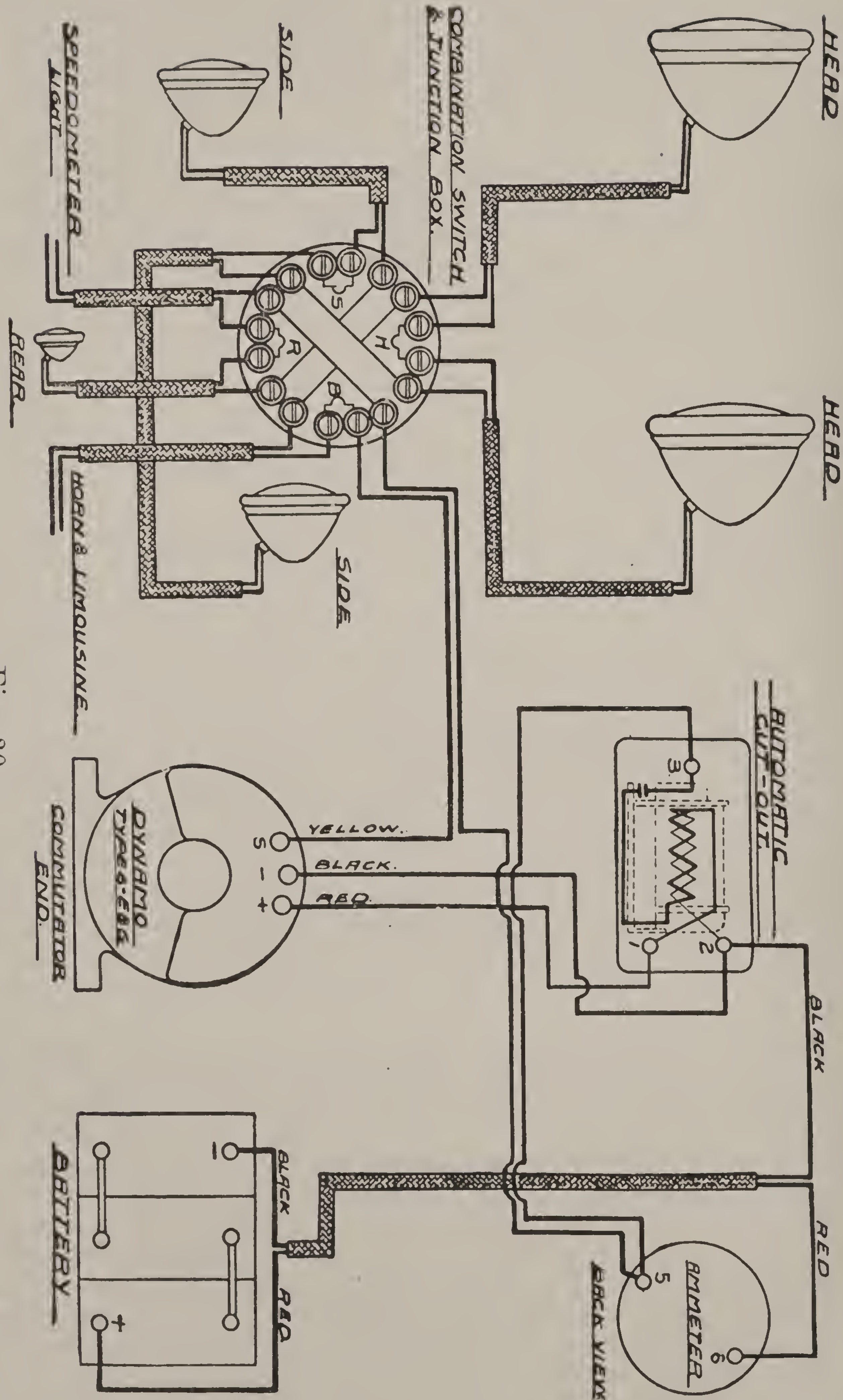


Fig. 30.
Wiring Diagram of Gray & Davis Lighting System.

NORTH EAST STARTING & LIGHTING SYSTEM.

The Northeast is used on cheaper cars and is being equipped on a great many Fords. You will find the storage battery about double the capacity of the ordinary storage battery, but is a split circuit. I mean by that, one-half of the pressure is feeding to one-half the lights, where the other half is feeding to the other half of the lights. Through this there will only be one-half of the pressure being used. If we were to use the full pressure on the lights, we would burn them out. We use the full pressure for starting the starting motor. This starting motor is a dynamo and starting motor combined, which is a compound wound motor, otherwise it operates as a motor and operates as a dynamo. When the circuit is flowing through the starting motor or it leaves the storage battery at about 12 volts, returning to the storage battery again from where it started, but when the lighting switch is turned on, the current leaves the storage battery one-half its pressure to one-half the lights, and returns and leaves the other point of positive one-half its pressure and returns.

In this system you will find one current flowing in one direction and one-half of the current of this battery is flowing the opposite direction over the same wire. Don't be confused, thinking that these currents run into one another, because electricity does strange things and an electric current can be carried over a wire in two different directions on the same wire.

In connecting this, the starting switch is connected to the two center points. The negative of the starting motor is connected to the negative No. 3; the positive of the starting motor is connected to the positive point of the storage battery No. 2. The split circuit takes place at the center positive where it is connected to the lighting switch ground point. "H" leads to the headlights; "S" leads to the side lights and "TA" leads to the ammeter and tail light. One side of the lights must be connected to the wire leading from negative No. 3, where one-half of the lights must be connected to the wire leading to positive No. 2. The other side of these lights must be connected to the lighting switch, where the other side of the lighting switch must be connected to the pole line No. 6 which leads to the center of the storage battery. The current travels as such: We close the starting switch and the current from the positive point, No. 2 leaves the storage battery to positive point, No. 2 at the starting motor, No. 1 passing through the large fields, then passing through the commutator through the armature, returning out the negative No. 4 where it returns back to No. 3 at the negative of the storage battery. This puts the starting motor in cranking power, when doing so, the engine starts. When the engine starts, this is so arranged inside with two clutches that one clutch takes hold when the starting motor is in operation until the engine starts, when the engine turns the same clutch faster than the dynamo which causes it to slip, the other clutch, which is connected in the opposite direction, takes hold and turns this starting motor as a dynamo, then the current leaves the dynamo at positive No. 1, where it passes to No. 2 positive point of the storage battery, where it passes through each cell and passes out at No. 3, the negative, where it returns back to negative of dynamo No. 4 from where it started.

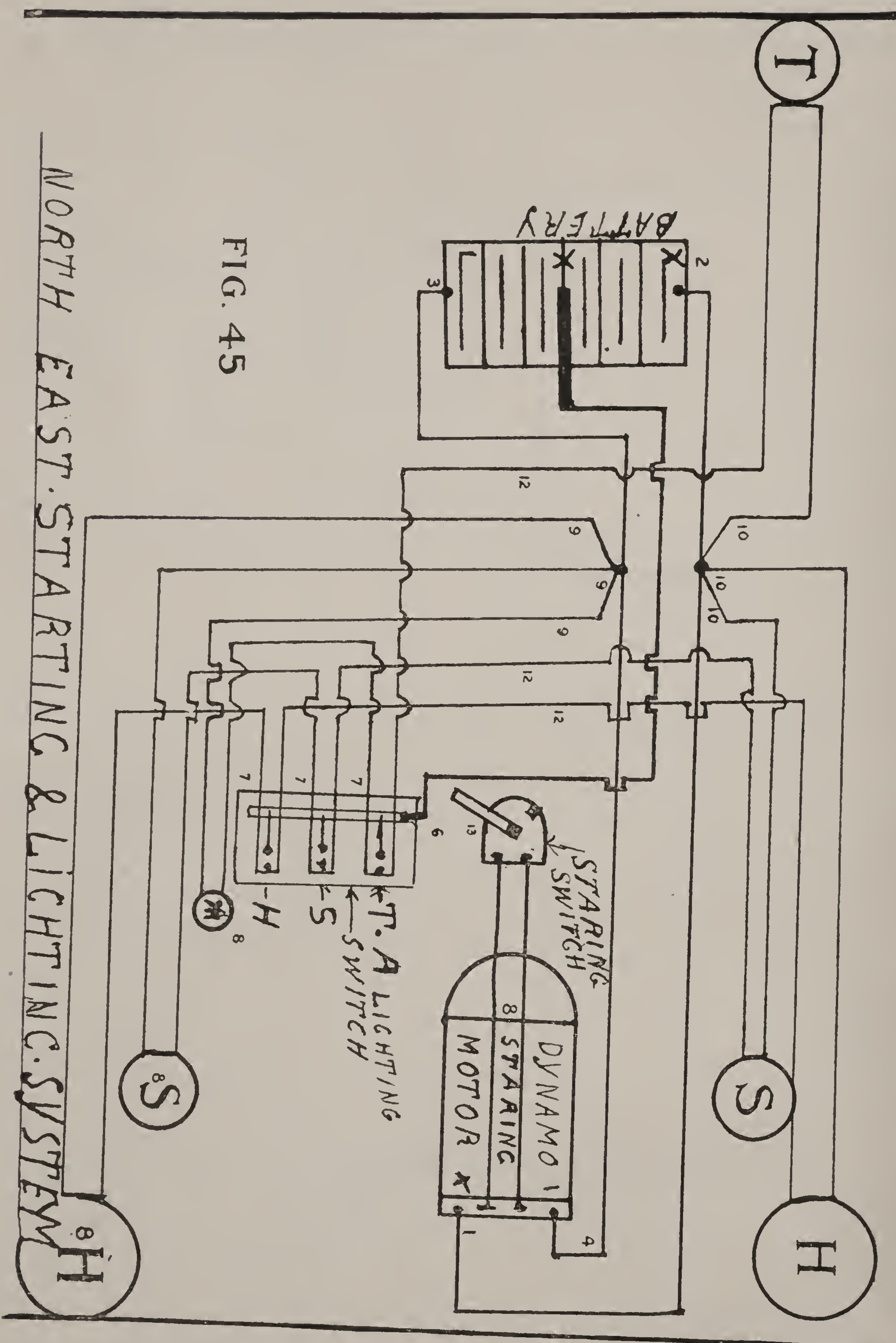


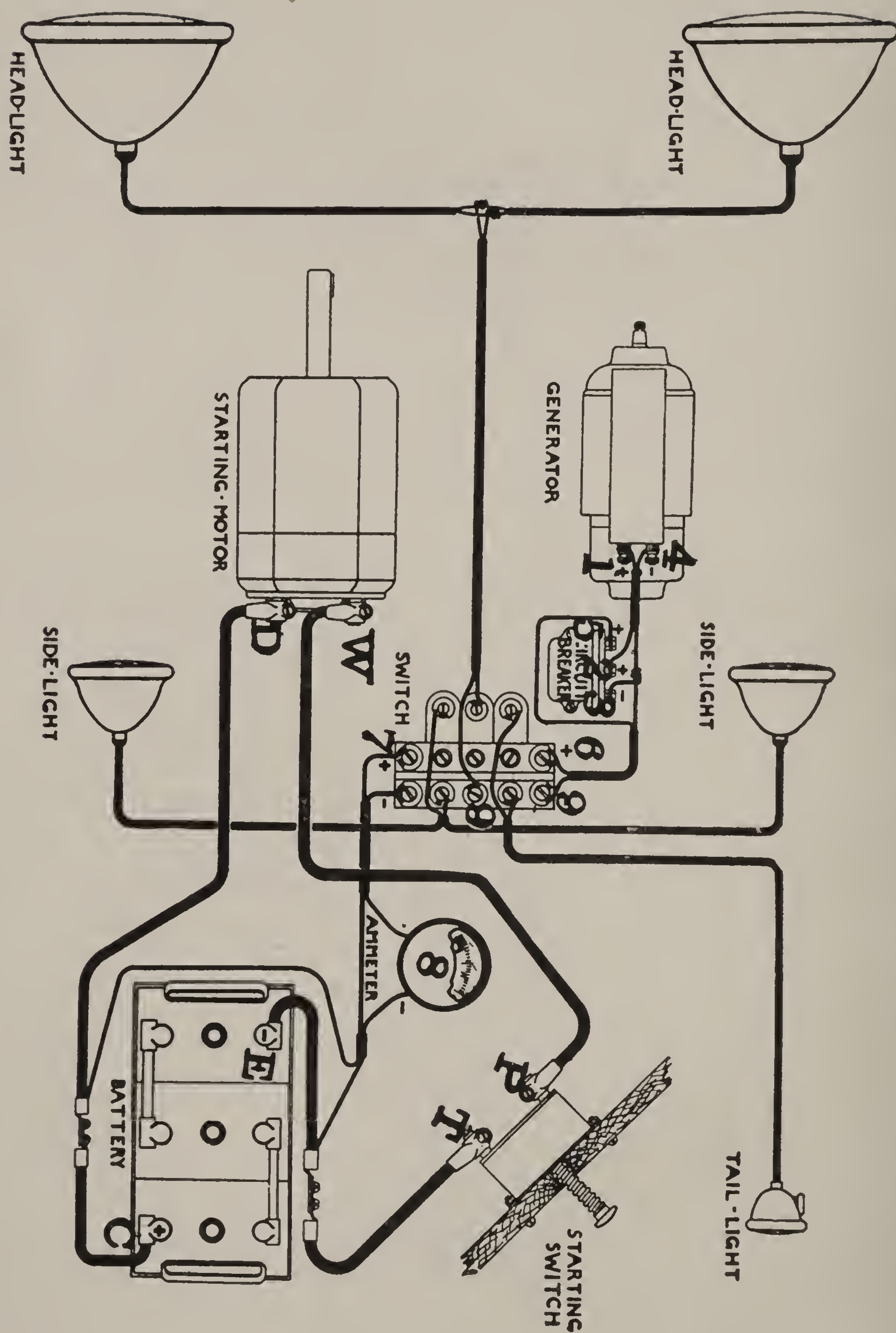
FIG. 45

NORTH EAST. STARTING & LIGHTING. SYSTEM

If the current passes to the lights, you will find that the dynamo only puts out 6 volts where the current leaves the line passing to the side lights No. 10, and headlights and rear, returning from the rear, side light and headlight over No. 12 to the switch "T, S and H," where it returns over the pole line 6 back to the center point of the storage battery, then over to No. 3 where it returns back to the dynamo, the point of starting. The same on the other side, the current will pass out at positive center point, where it passes over the pole line to the switch out on the line 7 to 8, through the lights and back to No. 9 where it returns to the dynamo negative from where it started. The same takes place when the dynamo is not running fast enough to do this charging; the current leaves the positive point of the storage battery where it undertakes to go back through the dynamo, but is cut off by the cut-out relay, then leaving No. 2 it passes to the wires No. 10 through the side lights and head lights in rear, this half of the current passing back on wire No. 12 where it passes to the center pole No. 6 and back to the center line of storage battery, where the other current leaves at positive point over the center line, passing over the pole line to the switch out on wires No. 7 and returning through the lights 8 and back to No. 9, back to No. 3 negative point from where it started.

This system will be found a very easy system to handle and very easy to wire and runs very quiet. I should advise anyone who wishes to put a starting motor on a Ford to put this type on because it is made especially to fit a Ford and can be put on with very little trouble.

FIG. 53.



The Simple Auto-Lite Wiring System

Fig. 53 shows a simple auto light wiring system which you will find working absolutely the same as any of the other double unit systems that have been described. WD shows the starting motor, E shows the storage battery, E8 shows the ammeter, PT shows the starting switch, 5 shows the cut out relay, 4 shows the dynamo.

In wiring up, always be sure and wire the positive point of your dynamo to the positive point of the cut out relay. Do not fasten any other wire between these two points. Then fasten B positive, which is shown here at No. 5, to the positive point of the storage battery, which here shows running to the junction block or lighting switch, and from there to the positive point of the storage battery. Then the current must return back to the dynamo from where it started, but returning through an ammeter or else it must pass through the ammeter before entering the battery. Do not put the ammeter between the wire on the starting motor and the starting switch. The current must return from the negative point of the cut out relay, also to the dynamo negative, You can fasten everything that you want to fasten on to the storage battery from the positive point at the cut out relay No. 5 and return back to No. 3 at the cut out relay. The current from the storage battery to the starting motor can not be wired up wrong as you can not fasten the wires wrong as you fasten one wire from the starting motor to the starting switch and from the starting switch to the storage battery and from the storage battery to the starting motor again. When starting you push down on the starting switch, the current leaves the positive point of your storage battery C, where it passes to D, through the starting motor and out at W, and from W to P, at the starting switch, from P to 2, and from T to E, the negative point of the storage battery from where it started. This puts your motor in motion when the current starts, then from the generator leaving the positive point No. 1, passes to the positive point at the cut out relay No. 2, through the shunt winding, returning to negative point of the cut out relay Nc. 3, back to the dynamo again, No. 4, from where it started. While passing through the shunt winding, it creates a line of force which causes it to attract a plate, closing the series circuit; the current then passes from the dynamo No. 1 to the positive point of the cut out relay No. 2, through the series winding and out at No. 5, where it passes then to the lighting switch No. 6, out at No. 7, passing to the storage battery C, through the battery out at E; from E it passes to the negative point of the ammeter 8, from the ammeter to negative at the lighting switch, through at No. 9, back to the negative point of the dynamo No. 4 from where it started. In case the light is turned on, the current then passes from the dynamo No. 1 to the cut out relay No. 2, through the series, out at No. 5 to the lighting switch No. 6 to each and every light, returning back to the lighting switch at No. 9, returns to the dynamo again from where it started, No. 4. In case the car has been stopped and the dynamo is not running, the current then comes from the storage battery, leaving C it passes to No. 7 and undertaking to pass through the cut out relay at No. 5, would change the polarity, throwing the two points apart and the current then could no longer flow through the cut out relay since it would have to pass from the lighting switch to each and every light, returning to the lighting switch to No. 9, where it would return through the ammeter or shorting its discharge and back to the storage battery No. E from where it started.

HARD QUESTIONS ABOUT THE AUTOMOBILE PLAINLY ANSWERED

Question. What is the most important part of an automobile?

Answer. The steering apparatus, because you depend your whole life upon it, the same as a pair of lines.

Question. What is a clutch?

Answer. A clutch is a device to release the motor power from the transmission.

Question. When do you release a clutch, and how?

Answer. You release the clutch when starting, changing speeds, coasting, and putting on brakes. When starting your car you release the clutch clear out so as to stop the jack shaft, but after once running, and changing speeds, you only release far enough to release the motor power from the transmission, so as to not stop the jack shaft.

Question. How can you tell the way a motor fires?

Answer. By watching the exhaust valve on No. 1 cylinder open and close. Then watch for No. 2 and 3, the one that operates after No. 1, shows the way the motor fires. If it is No. 3, it fires 1, 3, 4, 2, but if it is No. 2, it fires 1 2, 4 3, always going to 4 the third shot.

Question. How can you find compression stroke dead center?

Answer. By watching the exhaust valve open and close on No. 4 cylinder, and then getting the dead center mark even with the center of the cylinder, you have compression stroke dead center on No. 1.

Question. How do you set a timer?

Answer. Put your No. 1 cylinder on compression stroke dead center, then set the timer just ready to make contact with one of the contact points.

Question. How many different ways can a four-cylinder motor fire?

Answer. It can fire two—1, 3, 4, 2; 1, 2, 4, 3.

Question. How do you adjust valve rods?

Answer. By putting No. 1 cylinder on compression stroke dead center, then adjust the intake valve and exhaust valve, so that you can slip a business card between the push rod and the valve stem, then turn the motor half over, and adjust the next cylinder that fires in the same manner, then turning it half over again you adjust the next cylinder that fires, and so on till you have them all adjusted.

Question. When should you adjust valve rods?

Answer. After doing valve grinding or before doing valve timing, or any time you hear a clicking coming from the push rods.

Question. How do you find the exact dead center of a fly wheel?

Answer. By putting No. 1 cylinder piston at the highest point, place a mechanical rule into the head of the cylinder thereby dropping the piston one-quarter of an inch, then place a triam at the lower point of the fly wheel and to a counter punch mark made on the frame; make a temporary mark at the point of triam on fly wheel, then turn fly wheel the other way, dropping the same distance one-quarter of an inch, the same as the piston was on the other side, then place triam at the same counter punch mark, and then to the lowest point of the fly wheel make another temporary mark. Divide the distance between these two temporary marks on fly wheel, make a counter punch mark in the center; turn the fly wheel back until the triam will hook in the counter punch mark on the fly wheel, and on the frame of the motor, then you are ready to place the exact dead center mark on the fly wheel at top even with the center of the cylinder, and a mark on the center of the cylinder to correspond with the mark on the fly wheel.

Question. What is a triam?

Answer. A triam is a quarter-inch rod cut 15 inches long, each end sharpened to a sharp point, one inch of each end bent to an angle of 90 degrees.

Question. How do you figure the degrees of a fly wheel?

Answer. Measure the circumference of the fly wheel in inches, and divide the number of inches into 360, giving you the degrees of 1 inch.

Question. What degrees does the exhaust valve close, and the intake valve open?

Answer. The exhaust valve closes between 5 and 10. The intake valve opens between 6 and 12.

Question. How do you set the cams on the cam shaft to make the valves open and close at the proper time?

Answer. By first adjusting the push rods so you can slip a business card between them, while the cams are in the clear, then turn the exhaust mark even with the center of the cylinder, turn the exhaust cam up till it raises the push rod against the stem ready to leave, slip the gear on, then turn the intake degree mark even with the center of the cylinder, turn the intake cam up till it raises the push rod against the stem ready to open, and you have your cams properly set.

Question. How do you adjust a Schebler carburetor?

Answer. For a 20-H. P. motor, open the needle valve ¾ of a turn. For a 30-H. P., one turn; 40-H. P., 1¼ of a turn. Adjust your air valve till you have about ½ of its tension tightened. Start motor; leave spark retarded while the motor is running slow. Adjust the air valve till the motor hits regular, then open the throttle wide open. While the motor is running at high speed, adjust the needle valve until your motor hits regular, then throttle down and touch up your low speed again with the air valve.

Question. How do you adjust the Model F Schebler with a water jacket?

Answer. Open needle valve one turn. Tighten your air valve spring up about one-half, then start your motor; close your needle valve then till motor starts to missing, then open again till the motor hits regular on all cylinders; then adjust air valves till motor runs perfect at low speed; then open throttle half way, adjust the first adjustment screw on throttle till motor runs perfect; then open throttle wide open, turn the last screw on throttle till motor runs perfect at high speed.

Question. How do you adjust a Stromberg carburetor?

Answer. Let the gasoline fill up about 2-3 in the float chamber, by the adjustment screw above; then start the motor; tighten the light air valve spring about ½; then adjust gasoline till it stands about ½ while motor is running; open throttle wide open and adjust heavy air valve spring till motor runs perfect at high speed; then throttle your motor down till you almost count the explosions, adjust the light air valve spring till motor runs in perfect tune.

Question. What two things should be in first-class shape before undertaking to adjust a carburetor?

Answer. First see that your gasoline is flowing free and the ignition system is in first-class shape.

Question. Name the sound received from too rich a mixture or too weak a mixture?

Answer. When too rich, you have a sluggish, puffing sound; but when too, weak, you have a low, hollow tone sound.

Question. Name the color of blaze we receive from too rich or too weak a mixture.

Answer. If too rich, we receive a red, smoky blaze; if too weak, we receive a yellowish green blaze.

Question. Name the proper color of blaze and the proper sound we should receive from the proper mixture.

Answer. We should receive a deep blue blaze and a sharp report, like two pieces of boards being slapped together.

Question. What is a vaporizer?

Answer. A vaporizer takes the place of a carburetor, can only be used on stationary gasoline engine satisfactorily.

Question. What is a "Homo" fuel mixer?

Answer. It is a device to mix air and gas more thoroughly; resembles a fan. Is found in the intake manifold just above the carburetor.

Question. What causes a pound, and what should you do when you hear it?

Answer. A pound is caused from something coming loose or broken. You must stop as soon as possible.

Question. If a motor runs nice on a level road, but knocks on a hill, what is the trouble?

Answer. Your spark is carried too far advanced. Retard your spark.

Question. What should a man do before undertaking to start a motor?

Answer. Heed this question! See that your lever is in neutral. This may save your life.

Question. What should you do going down hill if you come to an icy, slippery place?

Answer. In seeing this place ahead of you, release your clutch and brakes, and let your car coast over.

Question. What is the pressure of a horse power?

Answer. The pressure of a horse power is the pressure that will raise 33,000 pounds one foot high in one minute.

Question. How do you figure the horse power of a gasoline engine?

Answer. Square the diameter of the piston in inches, multiply 410 times the diameter, times the number of cylinders gives you the pressure of the horse power.

Question. How do you prevent carbon from gathering too fast?

Answer. By putting No. 1 and No. 4 cylinder on dead center, and squirting coal oil in the head of those two cylinders, leave stand over night, next night do the same with 2 and 3.

Question. How do you grind valves?

Answer. By taking a very fine emery dust, or powdered glass and mix it with oil until it is like a salve, then place it on the valve seat, turn the valve back and forth, raise the valve up every dozen turns, give it one-quarter turn, keep this up till you have a perfect seat, and the pits are ground out. Don't ever turn a valve round like you would a bit.

Question. How do you fix a broken shaft temporarily?

Answer. Place four pieces of iron or wood on each side, then wrap with wire tight, the same as a broken arm in splints; then fasten a wire or rope to the front universal joint, and wrap in the opposite direction from the way the shaft turns, and fasten to the back universal point, and you can drive home.

Question. How do you get in with transmission gears stripped out?

Answer. High is a speed that can't be stripped out on the most of transmissions. Throw into high speed, leave the clutch in easy, hold the speed of your motor high, till you get your car started, drive home on direct drive.

Question. How do you get in with the connecting rod broken?

Answer. Take off the cylinder, remove the piston and broken connecting rod; take out the intake push rod, put your cylinder back on, drive home on what cylinders you have left.

Question. What is the cycle of a four-cycle motor?

Answer. The cycle of a four-cycle motor is one which completes four duties in two revolutions.

Question. What is the cycle of a two-cycle motor?

Answer. The cycle of a two-cycle motor is one which completes four duties in one revolution.

Question. What is the duties of a gasoline engine?

Answer. Exhausting, suction, compressing and explosion, one power stroke and three idle strokes.

Question. How do we scrape inbearings?

Answer. Take Persian blue paint and paint your shaft just as light as you possibly can get it on, place the shaft in the bearing or the bearing on the shaft, turn it around, then take it off, scrape off all points on bearings that paint rubs off on. Do this until the paint will rub even all over the bearings.

Question. How do you fix a cracked cylinder temporarily?

Answer. Get a powder that is called smoothon, mix with water till it is like mortar, rub it in the crack and smooth it over. When this becomes dry it gets hard like iron.

Question. How can you tell if the water is circulating?

Answer. By taking hold of the top hose on the radiator you can feel the water going through. Take off the radiator cap, sometimes you can see the water pumping in.

Question. How can you tell if your water pump is working?

Answer. Place a screw driver to the pump in your teeth, plug up your ears with your fingers, and you can hear if the pump is running or not.

Question. What is an air lock and where it is found?

Answer. An air lock is air lock between pipes by water, is found in the radiator, and caused by pouring water in too fast.

Question. What trouble does an air lock give, and how should we remove it?

Answer. It causes the water to boil and motor runs hot. The best way to remove it is to leave the water out and leave motor run while water is running out; fill your radiator slow.

Question. How do we loosen the piston on a motor that is stuck by gum, which is caused by poor lubricating oil?

Answer. If you have wood alcohol, pour it in the cylinders, work them up and down by hand till they turn free. If alcohol cannot be had, use coal oil; if not coal oil, use gasoline. Remove oil from crank case and pump, fill with a good grade of oil.

Question. How many pounds pressure should we pump a tire up?

Answer. 28x3, 30x3, 32x3, 60 lbs.
30x3½, 32x3½, 34x3½, 36x3½, 70 lbs.
30x4, 32x4, 33x4, 35x4, 36x4, 37x4, 80 lbs.
34x4½, 35x4½, 36x4½, 37x4½, 42x4½, 90 lbs.
35x5, 36x5, 37x5, 100 lbs.
32x5½, 110 lbs.
41x6, 120 lbs.; in real hot weather make this about 8 lbs. less.

Question. What is an anti-freezing process and how do we mix it?

Answer. One-third wood alcohol, about one pint of glycerine, and the balance water; it is a solution we use in the radiator in winter to prevent it from freezing.

Question. How many kinds of intake valves have we?

Answer. Mechanical and automatic.

Question. If a motor runs strong on the level but fails on a short hill, what is the trouble?

Answer. Poor adjustment of the carburetor.

Question. What are the cams used for on a cam shaft?

Answer. To open the intake and exhaust valve.

Question. How do you fix a friction clutch temporarily if it was slipping on the road?

Answer. By driving something thin such as hack saw blades under the leather, you will be able to drive in.

Question. How do you equalize the brakes?

Answer. By jacking the car up, and tightening your brake rods just so that when the brake is locked a little it is just as hard to turn one wheel as it is the other.

Question. What causes tires to rot?

Answer. Setting in the light, driving over oily boulevards or allowing oil to gather on the casing.

Question. How should you turn a corner on a slippery street?

Answer. Release your clutch and allow car to coast.

Question. How should you cross street car crossings or other dangerous points?

Answer. Slow your car down until you have it under control. Look both ways and see that you have the clear, then cross over.

Question. Driving in a hilly country, what precaution should you take to keep your motor running cool?

Answer. After climbing the hill starting down the next, drop into first or second speed, throw off the switch and let the vehicle drive the motor, the water is circulating, the fan is running, the cylinders drawing in cold air, and the motor is cooling; just before reaching the bottom turn on switch. Your motor will start again.

Question. How do you vulcanize a blow-out?

Answer. The casing must be cut out in layers on the inside, build in from the bottom up with fabric, then the outside must be built over with prepared gum, then it is ready for curing.

Question. How much heat should you carry on an electric vulcanizer?

Answer. Carry your heat at 260.

Question. How much heat do you carry on a steam vulcanizer?

Answer. 45 to 50 lbs., it depends on the kind of gum you use.

Question. If you break a rear wheel down how would you get home?

Answer. Put a pole under the rear axle, fasten it to some part of the motor which does not interfere with the working parts, tie the broken wheel to the pole, and the other wheel has got to turn. That way you can drive home on low speed.

Question. Can we run with coal oil and gasoline mixed?

Answer. Yes, half and half, but it is not practical.

Question. In getting in a mud hole, what would you do if you had no mud chains?

Answer. Throw a lap robe, hay or grass under your wheels.

Question. If you come to a muddy road where your car gets one wheel on dry land and the other in the mud, what would you do to get through?

Answer. Take the pin out of the brake rod of the wheel that is on dry land, and lock your brake just enough so that both wheels will have to turn, and drive on through.

Question. How can you tell low, intermediate and high speed and reverse speed on a selective type transmission?

Answer. A short slot of the shifting guide is always high, straight across from it is first speed, at the other end of it is second speed, angle ways across is reverse. With one without the guides the high will never shift back as far as the other three points, with the shifting lever.

Question. Describe the difference between a live and dead axle?

Answer. A live axle is one which turns, a dead axle is one used on trucks or double chain drives.

Question. Explain the difference between a semi-floating axle and a full floating axle?

Answer. The semi-floating axle cannot be removed without taking the axle out from under the car and taking the differential apart; the weight of the car is carried on the rear axle. The full floating axle can be removed by removing the hub cap and pulling the axle out the way the car is carried upon the housing of the rear axle, for your axles have nothing to do but the driving.

Question. What causes pre-ignition?

Answer. Pre-ignition is caused from carbon getting hot and igniting the gas from its condensed heat.

Question. What causes black and white smoke?

Answer. Black smoke is caused by too much gasoline; white smoke is caused from too much lubricating oil.

Question. How many different shorts can occur in a spark plug? Name them.

Answer. Grease or dirt, or cracked porcelain.

Question. If a motor runs good and hits on four cylinders when running idle, but misses on one when pulling, what is the trouble?

Answer. You have a slightly cracked porcelain in which the current jumps through on heavy compression.

Question. How should you carry the spark on the road?

Answer. From one-half you should advance it to as far as you possibly can. It depends upon the speed you are running.

Question. How do we clean a dirty magneto?

Answer. By taking it off and sousing it in a bucket of gasoline until you have all the grease washed out. Let it dry, oil its bearings and put back on.

Question. Should a magnet be set on an iron frame?

Answer. No, it should be set on brass, aluminum, copper, or some non-conductor.

Question. How do you test a unit?

Answer. Remove the unit that is not working, place one of the units that is working in the place of the one that is not working, and place the one that is not working in the place of the one that is working, and see if they will work vice versa.

Question. How do you adjust vibrator springs?

Answer. Short circuit your timer points one by one, and adjust each vibrator until you get a rich honey bee hum.

Question. A continued buzz in the vibrator, back firing in the carburetor, what is the trouble?

Answer. A continual buzz in the vibrator, back firing in the carburetor, the trouble is found in the commutator; is caused from the short at the timer, oil soaked wires, insulation broken, dirt built across the points of the timer, or wire laying on the frame of the motor.

Question. Give four causes of back firing through the carburetor?

Answer. Short in the timer, pre-ignition, improper valve timing, carbon under intake valve, weak mixture.

Question. How can you tell when the timer slips?

Answer. Your motor will lope or will not run at all, which can be told by putting No. 1 cylinder on compression stroke dead center, and see if your timer is just ready to make contact on the No. 1 point.

Question. What trouble does a worn-out timer give?

Answer. It makes the motor run irregular, more so when the motor is running fast; can be told by placing the finger on the end of the timer.

Question. What breaks a coil down?

Answer. Using more batteries than necessary.

Question. What causes a coil to burn completely out?

Answer. Too much voltage and the condenser not taking care of the current.

Question. What is a condenser for?

Answer. A condenser is to take care of the unnecessary current of the primary circuit, and to take care of the point of breaking and to prevent them from pitting.

Question. Do all coils have condensers?

Answer. No, only induction.

Question. What steps the current highest, induction coil or spark coil?

Answer. The induction coil.

Question. What is the difference between a spark coil and induction coil?

Answer. A spark coil has but one single winding. An induction coil has two, the primary and secondary.

Question. What causes a high tension current?

Answer. The primary current flowing over the wire creates a line of force, the breaking of the line of force creates a high tension current.

Question. How many dry cells should we use on a vibrating coil?

Answer. Not more than six.

Question. How many dry cells should we use on a magneto coil box?

Answer. Four is plenty.

Question. What do we test dry cells for, amperes or voltage?

Answer. Amperes.

Question. How do you test storage batteries and why?

Answer. We test a storage battery with a voltmeter; in testing it any other way we cause a current to rush out too fast and discharge the battery so fast that it would ruin your plates.

Question. How many amperes does a dry cell test when new?

Answer. Thirty amperes.

Question. How much voltage does a dry cell test when new?

Answer. One and three-tenths.

Question. What does a storage battery test to the cell?

Answer. Two and two-tenths.

Question. How do you time a magneto in itself?

Answer. Set the interrupter so it breaks one-sixteenth of an inch when it is broken in its full distance, then turn back till it is just ready to break; set the distributer one-third on, have the spark retarded, then slip gears on.

Question. Do we use batteries on high tension magnetos?

Answer. Not unless they have a coil box in connection.

Question. Will a Splitdorf magneto run without brushes on the magneto?

Answer. No, because the current is fed from the magneto through the brushes.

Question. Will the magneto run on the batteries without brushes?

Answer. Yes, for the battery current does not pass through the brushes.

Question. How do you test the priming wires on a vibrating coil box?

Answer. Fasten the wires to the terminals of the units, and short circuit them one by one, and this way you can tell which wire is connected to which unit you desire to wire to your timer point.

Question. How can you tell the ground wire from a brush wire and the interrupter wire apart if the colors on a Remy coil would not show up?

Answer. Fasten the two battery wires together; turn your switch on the battery, strike your colored wires on your battery on the zinc and carbon; the only two that will spark together is the brush and interrupter wire, the other wire is the ground. Take your ground wire and hold it in your hand or mark it, then turn the switch on the magneto, then place your ground wire on the zinc, and strike one of the other wires with it on the carbon, the wire that will spark with it is the interrupter wire, the other wire is the brush.

Question. How do you set the magneto when putting it on a motor?

Answer. Retard the spark; set your distributer one-third on, and set the interrupter just ready to break; put your No. 1 cylinder on compression stroke and set the magneto on, and secure it fast.

Question. How do you set a Uno sparker?

Answer. By having your No. 1 cylinder on compression stroke dead center, set the timer so it is ready to make contact with the spark retarded, then place the fiber lid over the top, place the distributer brush on and notice the direction it is pointing in and place the distributer on and the terminal it points to is No. 1.

Question. What is the difference between a make and break and a jump spark?

Answer. The make and break, the current is made and broken, the spark taking place at the point of breaking, and the coil not having a condenser. The jump spark is created by an induction coil, jumping across points.

Question. What is a magnetic spark plug, a make and break or a jump spark?

Answer. It is a make and break spark, the primary current passing through the plug creates a line of force in the plug causing a plate to become magnetized in the plug, breaking the points apart at the plug, breaking the line of force, produces a spark at the plug.

Question. Would it be a good plan to put two new dry cells with four old ones?

Answer. No, the four old ones would spoil the two new ones.

Question. Does it make any difference which side of your battery you connect to the ground?

Answer. No, it does not.

Question. What is the ground of an automobile?

Answer. The frame of the motor.

Question. Do we have to have ground on all systems?
Answer. We do, for the high tension current to travel back.

Question. How many different kinds of propelling vehicles are there?
Answer. Three—steam, gasoline, electric.

Question. Who invented the first four-cycle gasoline engine?
Answer. Booty Roe.

Question. What is a dual system?
Answer. Any two-circuit system.

Question. What is a complete dual system or double ignition system?
Answer. Two complete systems; if one may be wrong, the other is ready for work.

Question. Do two sets of spark plugs ever give trouble?
Answer. Yes, they become smutted up from not being used.

Question. What is meant by neutral?
Answer. Neutral is a point in which your lever stands when it is not in any speed whatever.

Question. Where do you locate the push rods?
Answer. Right below the valve stems.

Question. What causes back firing in the muffler?
Answer. Cracked porcelain, oil shorts in plug, carburetor not properly adjusted, worn out timer, platinum points, anything that will cause missing at the cylinder.

Question. What is a timer for on an automobile?
Answer. A timer is a device to time when sparks should take place in cylinder.

Question. What is an interrupter?
Answer. An interrupter is a device to break the primary current when the spark should take place in the cylinder.

Question. What is a distributer?
Answer. A distributer is a device to distribute the high tension current to the different cylinders as they should fire.

Question. What is a jump gap?
Answer. A jump gap is a device to take care of the high tension current in case a high tension wire comes off.

Question. Where are jump gaps found?
Answer. In high tension magnetos and some magneto coil boxes such as the Splitdorf.

Question. What are the magnetos on a magneto for?
Answer. To give off a line of force to cross the armature, so a low current can be started by breaking the line of force.

Question. What voltage is there in six dry cells, hooked in series?
Answer. Seven and eight-tenths.

Question. What voltage is there in six dry cells hooked in multiple?
Answer. One and three-tenths.

Question. How many amperes do six dry cells test hooked in series when new?
Answer. Thirty.

Question. What are the one to two gear and the two to one gear used for?

Answer. The one gear drives from the crank shaft to the two gear on the cam shaft and the two gear drives to the one gear on the magneto.

Question. From what part of the cycle do we get power on a four-cylinder motor?

Answer. The power stroke only, which may be the first and it may be the last, it depends on where you start in.

Question. What is the definition of a cycle?

Answer. The definition of a cycle is anything completing the same number of duties, coming back to the same point of starting, has completed a cycle.

Question. In climbing a steep hill what do you want, force or power?

Answer. We want power.

Question. What are the essential parts of a gasoline car?

Answer. Power, plant, carburetor, magneto, or ignition system, transmissions, oiling system, differentials, radiator.

Question. What made the gasoline engine famous?

Answer. The timer.

Question. How is the body attached to the car?

Answer. Generally from four to eight bolts through the frame.

Question. How is the speed changed and checked?

Answer. By advancing and retarding the throttle.

Question. What is the principle of the differential gears?

Answer. The differential gears are so that one wheel can stand still and the other one run twice as fast in turning corners.

Question. What is to be done with a leaky float or oil soaked float?

Answer. If a copper float take it out and solder it; if a cork float, take it and dry it and dip in shellac.

Question. How many different kinds of cooling systems are there? Name them.

Answer. Air, oil and water.

Question. How many water cooling systems are there?

Answer. Two.

Question. Name three kinds of transmissions?

Answer. Selective, progressive and planetary.

Question. Name four types of rear axles?

Answer. A dead axle, semi-floating, full floating, three-quarter floating.

Question. Name three types of differential?

Answer. Spur gear, bevel gear, universal.

Question. Where is the differential located in a double chain drive?

Answer. It is located in the center of the car, but you will find the differential and transmission together.

Question. What is the principle of a fly wheel?

Answer. To hold the vibration steady and to help your cranks over dead center, to hold your speed steady to help carry through the idle strokes.

Question. What is a two to one shaft?

Answer. A cam shaft to the crank shaft.

Question. What is meant by a mechanically operated valve?

Answer. A valve which is operated by some mechanical part of a machine, which is forced open.

Question. How is the mixture drawn into the cylinders?

Answer. By the suction of the piston.

Question. Name some carburetor troubles?

Answer. Leaky float, dirt in spray nozzle, pipe line stopped up, water in gasoline.

Question. How many speeds has a planetary transmission?

Answer. Two ahead and one reverse.

Question. What is a propelling shaft?

Answer. A shaft which drives from the differential to the transmission.

Question. What is the drive shaft?

Answer. A shaft with a sliding gear and a transmission.

Question. Where is the torsion radius rod used?

Answer. Beside the propeller shaft, from the transmission to the differential.

Question. What is meant by tappets?

Answer. Push rods.

Question. When an engine is hard to start, what is usually the trouble?

Answer. Not good compression.

Question. What is liable to cause the sudden stoppage of an engine?

Answer. Primary wire coming off which breaks the primary current or the main high tension feed wire.

Question. How many valves has each cylinder?

Answer. Two, intake and exhaust.

Question. What advantage is there, if any, in reversing the current?

Answer. There is none.

Question. Name some of the simple magneto troubles?

Answer. Primary wires getting broken in two, weak batteries, batteries disconnected, bad platinum points, dirty magneto, weak magneto, magneto not timed properly, high tension wire coming off, poor connections in switch.

Question. Describe a T head motor?

Answer. A T head motor is the shape of a T with exhaust valves on one side, and intake valves on the other.

Question. Why would a motor pull on low speed and not on high?

Answer. The spark disconnected, carburetor not properly adjusted, spark not properly set, valves not properly adjusted.

Question. Why will an engine pull good on high speed and not on low?

Answer. Loss of compression, poor adjustment of carburetor, spark not set properly, weak magnetos.

Question. Why will a storage battery short out quicker than a dry cell?

Answer. A storage battery has no resistance.
Question. What is meant by a three-point extension?
Answer. A motor which is carried on three points.
Question. What is a primary current?
Answer. A primary current is the first current that flows.
Question. What is a secondary current?
Answer. A secondary current is the second current which is produced through the breaking of the line of force.

Question. How much of an air gap would you give a spark plug?
Answer. One thirty-second of an inch.

Question. What speed does a timer turn on a four-cycle engine?
Answer. One-half the speed of the motor.

Question. When is the master vibrator used?
Answer. It is generally used on vibrating coils; can be used on any system that is operated by a timer.

Question. What causes a motor to over-heat?
Answer. Poor circulation of water, poor circulation of oil, bad oil, or no oil at all, carrying spark too low, carbon.

Question. What indicates misfiring and finally stopping of the engine?
Answer. A gasoline pipe line being stopped up from the carburetor to the gasoline tank, the carbon getting under two or three valves, timer slipped.

Question. If the engine does not start what may be the matter?
Answer. No gasoline, no compression, no spark, timer not set right, spray nozzle stopped up, water in gasoline.

Question. How is the magneto grounded to the engine?
Answer. Through the frame or shaft.

Question. Explain how to reverse a motor?
Answer. By changing your cams on your cam shaft, to make them work in the reverse, which would not be a practical thing to do by no means.

Question. If an outer casing blows out on the road, what can be done?
Answer. If rope can be gotten, warp the rim with rope and run in on the rope; if not, run on the rim.
Question. How is faulty valve timing made known?
Answer. Back firing through the carburetor, or in the muffler, the motor has no power.
Question. If your car should catch fire what would you do?
Answer. Smother it with dirt or rags; don't ever throw water.
Question. How do you clean carbon out of a cylinder?
Answer. By using carbonizer or taking the cylinder out, and scraping them out.
Question. How does the engine transmit power to the rear wheels?
Answer. From the fly wheel to the clutch, to the jack shaft, to the drive shaft, to the propeller shaft, to the master gear, to the bevel pinions, to the bevel side gears, to the rear axle, to the rear wheels.
Question. What is meant by changing speed gears?

Answer. Changing from first speed to second, and from second to high, which is direct drive.

Question. How are different speeds changed?

Answer. By going to first speed we release the clutch clear out, but from first to second and second to high we only release the clutch far enough to release the clutch from the motor power.

Question. Can the gears be changed when the engine is running?

Answer. Yes.

Question. Why does the clutch slip?

Answer. To prevent the car from starting suddenly.

Question. What is meant by direct drive?

Answer. Direct drive means the same as one shaft connected from the fly wheel to the master gear.

Question. Is there anything to make a brake hold if it is slipping on the road?

Answer. By tightening your brake rods or throwing Fuller's earth on the legging.

Question. Is there any other means of checking a car on a steep hill?

Answer. Yes, by filling it in low speed, and turning off the switch, running again compression.

Question. How are the cranks of two, four and six cylinders arranged?

Answer. The two cylinder cranks are 180 degrees straight across, four cylinders are 180 degrees, one and four together and two and three together, six cylinders are 120 degrees apart; one and six together, two and five together, three and four together.

Question. Explain the action of a pneumatic tire?

Answer. When the car is traveling, the air is traveling in the opposite direction, and if you strike any small object on the road the air gives back absorbing the shock.

Question. How are the tires kept on the rim?

Answer. Some are kept on by clinchers, and some are kept on by rings.

Question. Does the tire get hot when running on the road and what causes it?

Answer. Yes. It is caused from the hot sun and roads, and the friction of air.

Question. Can you fix a puncture inner tube temporarily on the road?

Answer. Yes, with a cement cold patch.

Question. How long should the cement be left to dry before the patch is put on?

Answer. Fifteen minutes.

Question. Is there any other way of mending inner tubes?

Answer. Yes, with a button that is made for the purpose, and by vulcanizing.

Question. Are light tires better than heavy tires?

Answer. They are for light cars, but not for heavy cars.

Question. Which will last the longest, the one with the air or the one with the punctureless process?

Answer. The one with the punctureless process will last twice as long.

Question. Will it ride as easy?
Answer. No.

Question. Can it be used over?
Answer. Yes, as many times as you like.

Question. Is it safe to run with a tire down?
Answer. No, it will ruin your inner tube and casing.

Question. May not this injure the steel rim?
Answer. Not if you don't drive fast.

Question. What sometimes causes radiators to leak?
Answer. Sometimes from the motor being hot and the radiator cooling off too quick allows the tubes to shrink from the tube sheet, loose radiators cause the solder to be jarred loose.

Question. Should a man think he knows all about an automobile when he has these questions learned?
Answer. No, not with a thousand on top of them.

Question. What should be the specific gravity of a storage battery?
Answer. The specific gravity should read between a 1.280 and 1.300 if the battery is fully charged.

Question. If the battery is found to have low specific gravity, what is to be done?
A. The battery should be put on and charged at the 24 hour rate for several days until specific gravity in each cell has remained constant for one hour or more.

Question. Should the gravity remain low, refuse to come up, what should be done?
Answer. A small amount of pure sulphuric acid should be added to those cells which do not come up and the battery charged again at its finishing rate.

Question. If a battery is not in use, can it be stored away?
Answer. No, the battery should be kept charged.

Question. How often should battery be charged?
A. The battery should be charged at least every 3 or 4 weeks.

Question. Can the battery be charged with the dynamo sufficient when not being used?
Answer. Yes, by running the engine at a speed of about 20 miles an hour for one hour every two weeks.

Question. Should acid be added to a battery when solution becomes low?
Answer. No.

Question. What should be put in the battery when solution becomes low?
Answer. Pure distilled water.

Question. How high should the solution stand above the plates?
Answer. One-fourth of an inch.

Question. If pure distilled water cannot be secured, what can be used in its place?
Answer. Ice water or rain water after being filtered.

Question. How would you filter the water?

Answer: Through a piece of brown paper folded in the shape of a funnel.

Question. If the water gets real low in one cell, what is the trouble?

Answer. You have a cracked jar; must be removed and a new one replaced.

Question. How can you tell if your generator is generating if you have no ammeter?

Answer. By turning on the lights, watching the rail light when the engine starts, and notice if the rail light becomes brighter; if so, generator is generating.

Question. When engine is running ammeter does not register, what is the trouble?

Answer. Fuse burnt out, broken connections on generator, generator not generating, cut out relay points too far apart.

Question. What is the distance a point should be on a cut out relay?

Answer. 1-64 to 1-32 of an inch.

Question. If wire is broken on generator, how can you tell?

Answer. Generator will make a strange sound when running.

Question. Should generator run when disconnected, or storage battery disconnected?

Answer. No, not unless the terminals on generator are shorted together.

Question. If generator does not charge, what is wrong?

Answer. The commutator is dirty and should be cleaned with 00 sand paper.

Question. How often should the battery be filled with water when battery is being used?

Answer. In summer time, once a week, winter, once every two weeks.

Question. If ammeter hand lays clear over against pin on discharging side, what is the trouble?

Answer. The cut out relay is stuck and storage battery is discharging through the generator, providing it shows a charging rate when generator is running.

Question. If hand of ammeter lays against pin when engine is running or not running?

Answer. The ammeter has been shorted.

Question. What can be done when ammeter is shorted so it will not register correctly?

Answer. Take ammeter off and short circuit it on storage battery so as to throw it back.

Question. Will two currents of the same pressure travel in opposite directions on the same wire?

Answer. Yes.

Question. What causes lights to flicker?

A. Loose connections, loose lamps and socket.

Question. What causes lights to go out?

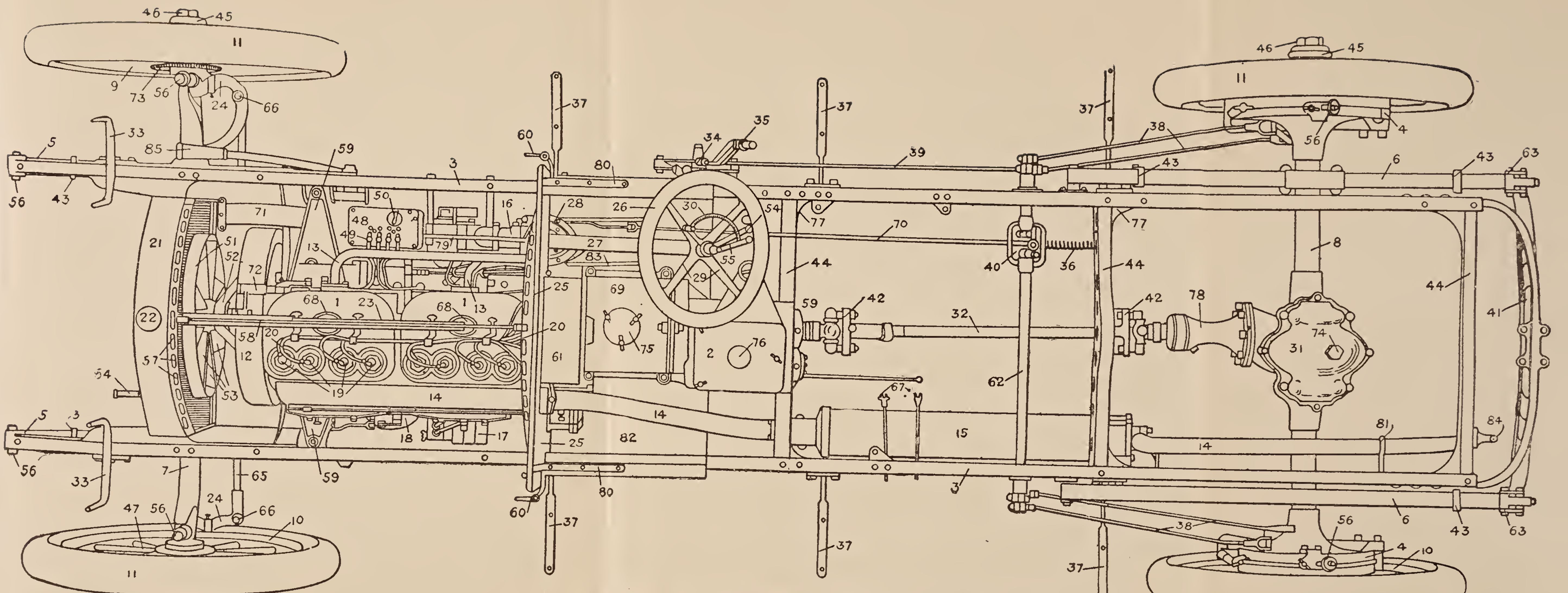
Answer. Loose connections on storage battery to generator, loose connections at lamp, broken wires at lamp, burnt out lamps.

Question. What should the voltage be when taken at a 24 hour charging rate?

Answer. 2½ volts per cell when the battery is full.

Question. If the solution should get spilled, what amount of water and what amount of acid would we use?

Answer. Add electrolyte, a solution which is composed of one part sulphuric acid and three parts water.



PLAN VIEW OF CHASSIS WITH SHAFT DRIVE

1 Cylinder castings
2 Change speed gear box
3 Side frames
4 Brake hand
5 Front springs
6 Rear springs
7 Front axles
8 Rear axles
9 Wheels
10 Rims
11 Tires
12 Fly-wheel
13 Water inlet pipe
14 Exhaust pipe
15 Muffler
16 Water pump
17 Magneto
18 Carburetor
19 Spark plugs
20 High tension wires
21 Radiator
22 Radiator cap
23 Water outlet pipe
24 Steering arm
25 Dashboard
26 Steering wheel
27 Steering post
28 Steering mechanism
29 Steering wheel spokes
30 Quadrant
31 Differential housing
32 Driving shaft
33 Gas lamp brackets
34 Change speed lever
35 Brake lever
36 Equalizer spring
37 Foot board brackets
38 Brake rods
39 Brake shaft
40 Brake equalizer
41 Platform spring
42 Universal joints
43 Spring clips
44 Frame cross member
45 Wheel hub
46 Wheel nuts
47 Wheel spokes
48 Mechanical oiler
49 Oil leads
50 Oil filler cap
51 Fan
52 Fan pulley
53 Fan blades
54 Throttle lever
55 Spark lever
56 Oil cups
57 Leather tape for radiator support
58 Tie rod for radiator support
59 Engine supports
60 Side oil lamp bracket
61 Dashboard coil
62 Brake equalizer bar
63 Spring shackles
64 Starting crank handle
65 Reach rod
66 Steering arm pivot
67 Muffler cut out levers
68 Water connection to radiator
69 Clutch casing
70 Brake pedal rod
71 Inlet water pipe
72 Fan belt automatic adjuster
73 Speedometer gear
74 Cap for lubricating differential
75 Clutch cover plate
76 Change speed gear box cover plate
77 Gusset plates
78 Thrust bearing and pinion housing
79 Oiler shaft
80 Dash board brace
81 Exhaust pipe bracket
82 Underpan
83 Clutch rod
84 Tail lamp bracket
85 Spring steering connection

INDEX

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